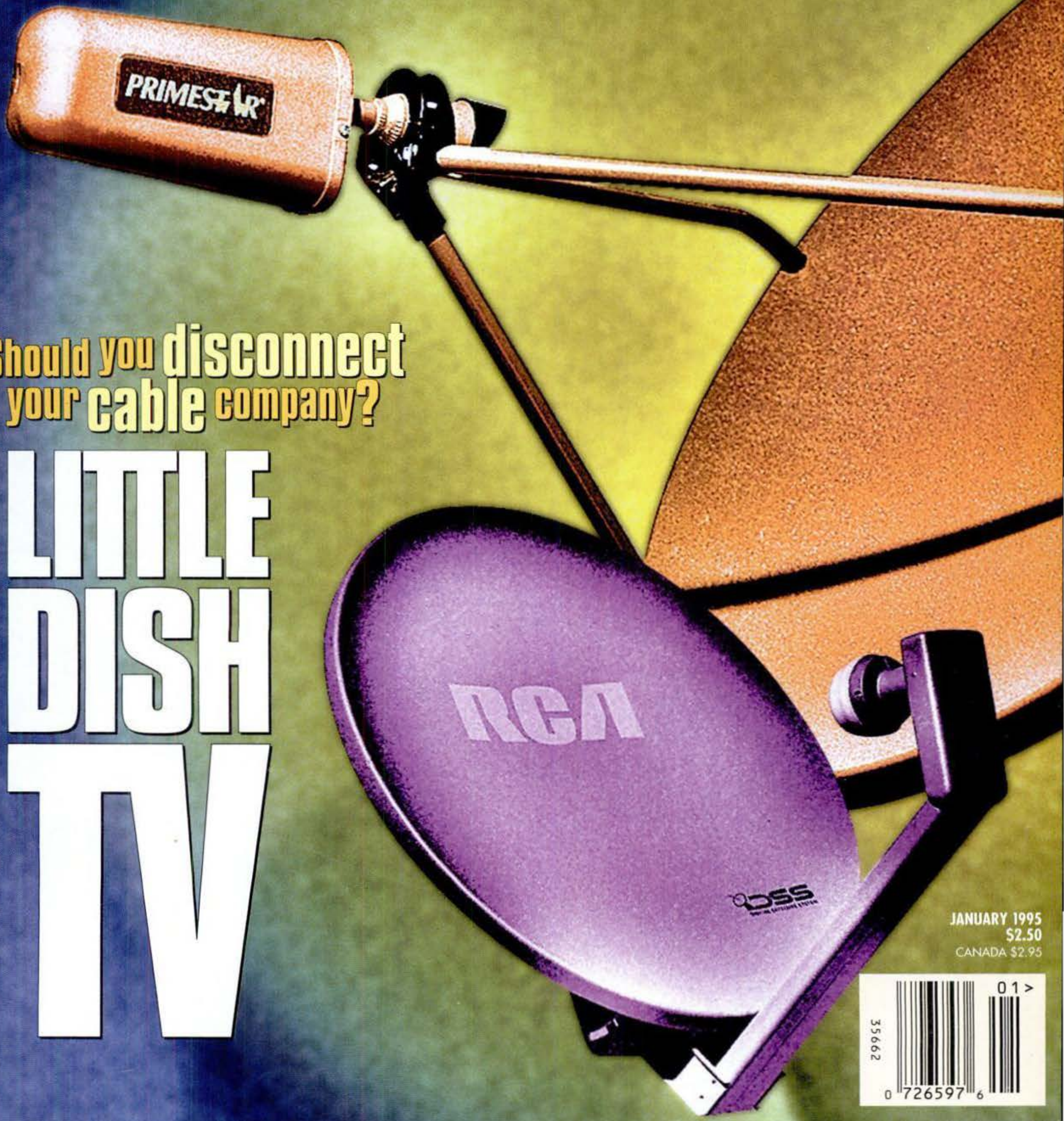
A Times Mirror Magazine

Popular Science

REVEALED: Stealth Attack Plane

Laser Beam Telescope



Should you disconnect your cable company?

LITTLE DISH TV

JANUARY 1995
$2.50
CANADA $2.95

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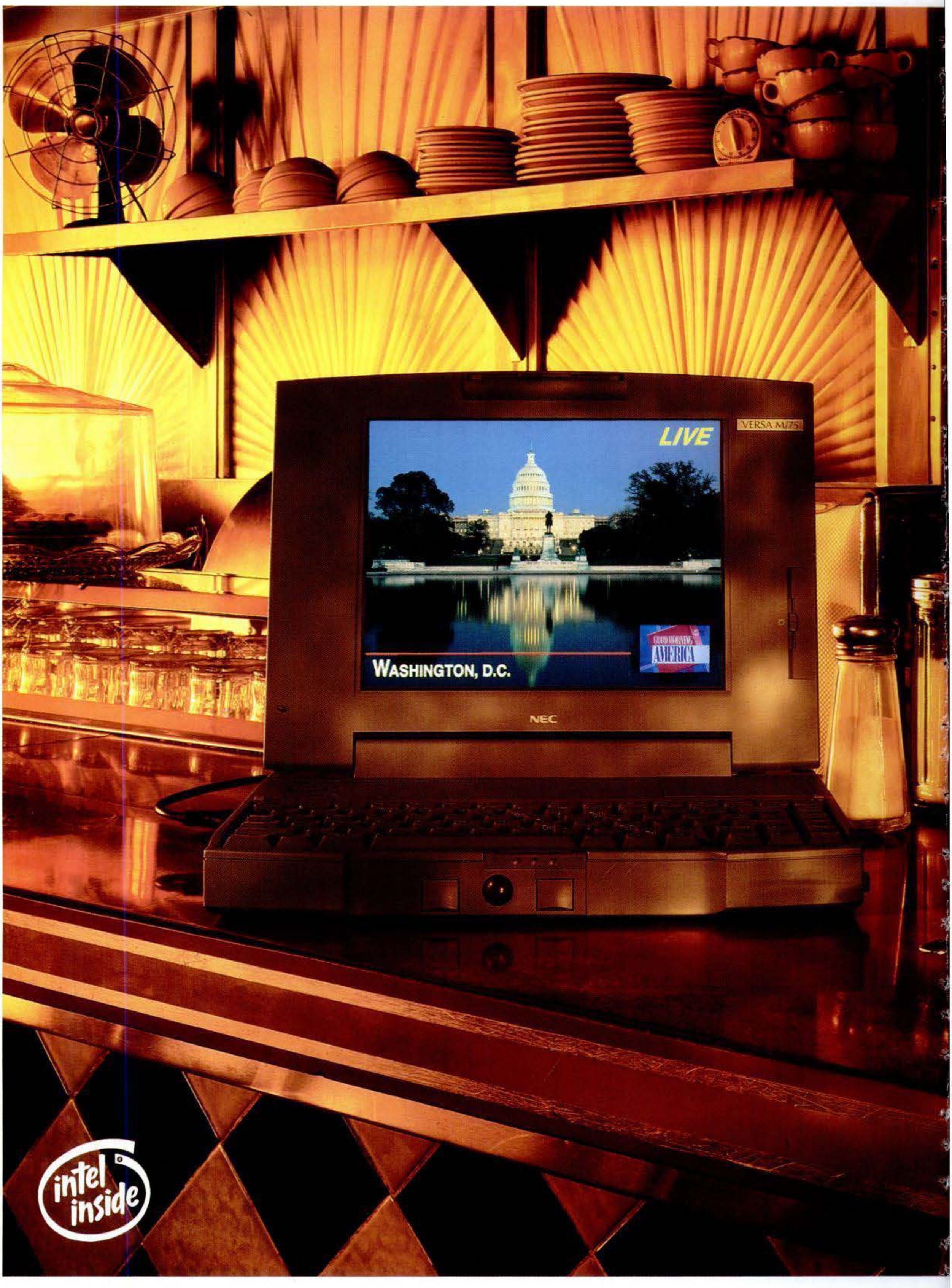

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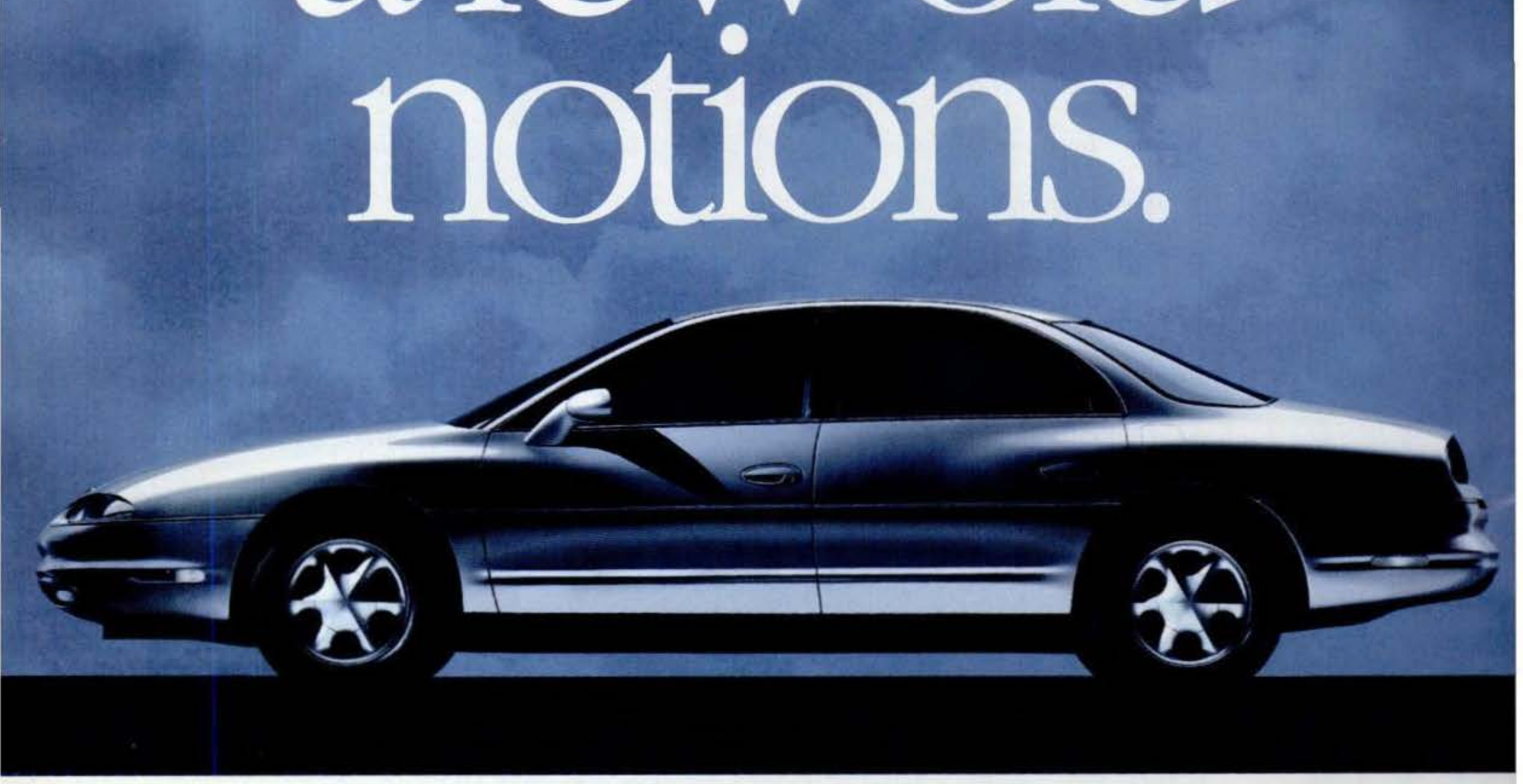
Pardon us while we annihilate a few old notions.



Its father was a Cruise Missile. Its mother was a concert hall. And it's three parts power, two parts elegance, and all parts incredible. It's the new, 32-valve, 250hp, DOHC V8 Aurora by Oldsmobile. But if you feel more comfortable calling it a luxury-performance sedan, go right ahead. Aurora by Oldsmobile. See what happens when you Demand Better. Call 1-800-718-7778.

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Popular Science

THE WHAT'S NEW MAGAZINE

JANUARY 1995

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VOLUME 246

NUMBER 1

COVER BY JOHN B. CARNETT AND TOM WHITE

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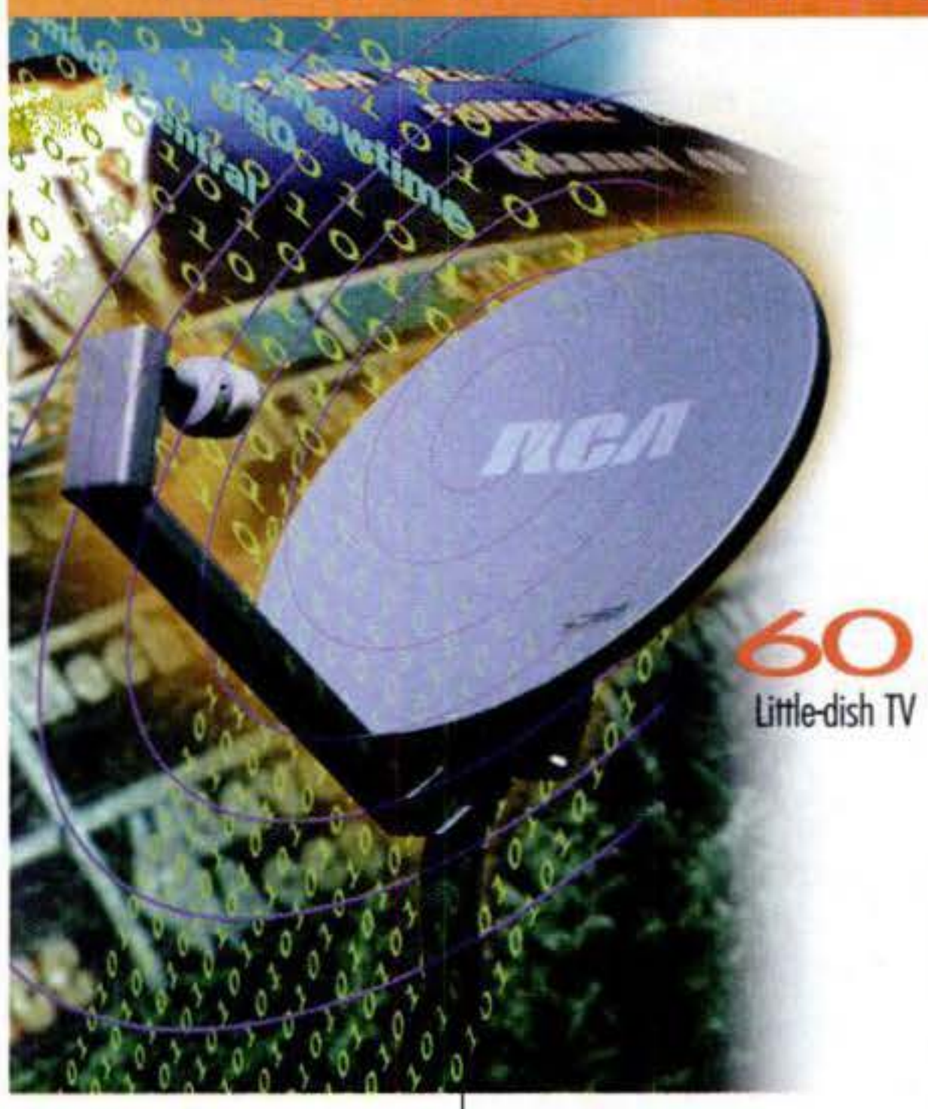

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Will a secret new supersonic bomber replace the aging F-111? Reports indicate the existence of an unacknowledged stealth attack craft that would offer covert strike advantages.

REINVENTING THE TELESCOPE 57

Weapons technology developed for the "Star Wars" program has a new mission: helping Earthbound astronomers improve their view of the heavens.

LITTLE-DISH TV 60

Tired of the tyranny of your local cable company? Here's the hands-on lowdown on the newest digital satellite receivers.

BABY ZOOMERS 66

Frustrated from wrestling with complex SLRs? Want something versatile that travels easily? Try one of the new breed of point-and-shoot 35mm compact cameras with zoom lenses.

THE FUTURE IS NOW 68

AT&T is trumpeting the promise that its technology will deliver a new tomorrow. Carl S. Ledbetter, president of the Consumer Products Division, is charged with making that happen. In an interview, Ledbetter offers an exclusive look at what AT&T has in store.

URBAN OASIS 74

Air and water are recycled at an innovative office building in Tokyo. Per-capita water consumption is cut nearly in half, and bird calls compete with the noise of traffic just yards away.

THE AMERICANS ARE COMING 76

American sports-luxury sedans challenge—and in some ways surpass—blue-blooded European benchmarks. We road-test the BMW 540i, Cadillac DeVille Concours, Mercedes-Benz E40, and Oldsmobile Aurora.

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EDITOR'S NOTE

HEAT SEEKERS IN A BRAVE NEW WORLD

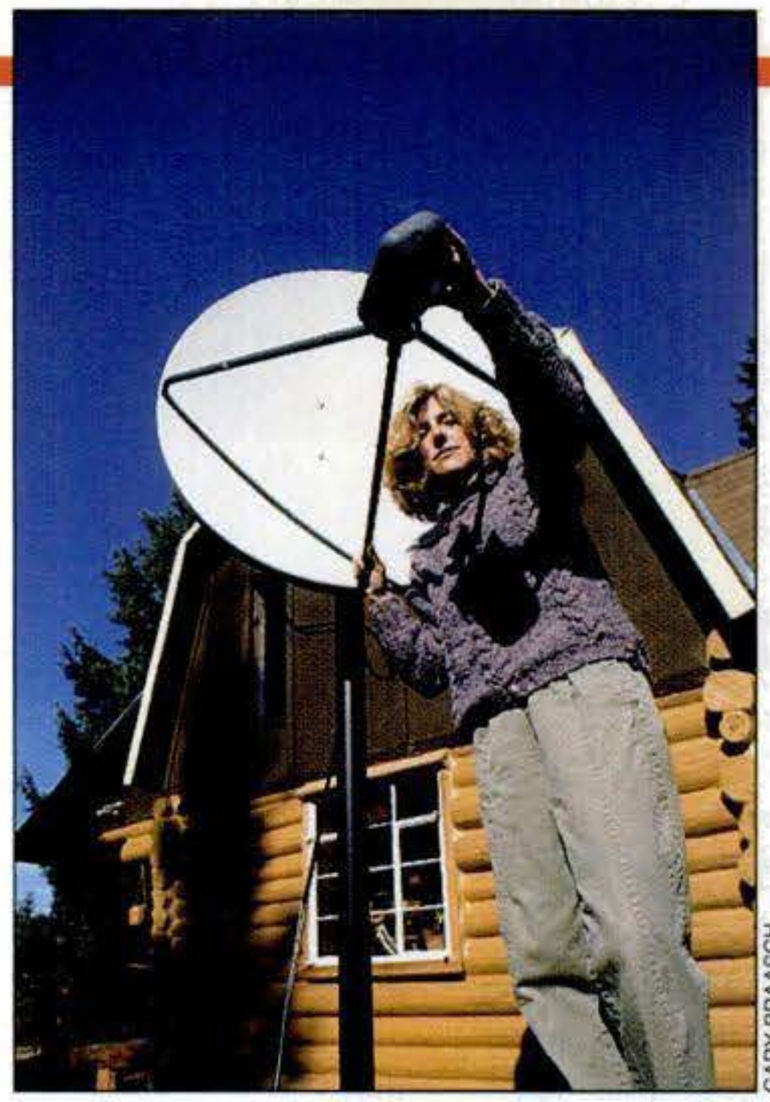
This month's cover story is a side-by-side analysis of the latest in digital TV technology. Nothing less than a communications revolution occurred recently in rural White Salmon, Wash., when this technology—a pair of digital TV satellite transmission receivers and their tiny dish antennas—was installed at the remote log cabin of Senior Editor Dawn Stover.

Stover is tethered to the world essentially by a telephone line that feeds her phone, her fax machine, and her computer. But her household is well beyond the reach of broadcast TV or cable. What many of us take for granted is, at Stover's house, a brave new world. Here's her summary of the difference in her life "AD"—After the Dish:

"Before the dish, I had only two channels to choose from, so I usually picked the one with the better picture—a lesser of two evils decision, really. I typically taped the evening news and one other program each day. That way I had something to watch whenever I had time for television. Now I have at least 150 channels, including premium movie channels and pay-per-view. In life after the dish, I waste a lot of time looking at the listings, channel hopping. I no longer record a lot of programs and I haven't been to the movie rental store in months."

He may not have a tiny digital TV dish installed yet at his suburban New Jersey home, but it may be just a matter of time for Carl Ledbetter. He owns four VCRs, six computers, and is at the answering end of 17 phone numbers, two of which are cellular portables and one that is a "reach-him-anywhere" 700 number. In terms of today's sophisticated electronics and communications, Ledbetter is known as a "heat seeker."

You might not expect anything less from the man who is in charge of turning the research and development curiosities of AT&T Bell Laboratories into real-world communications products for the rest of us. But there is something else about this math professor turned business executive that makes him a particularly interesting



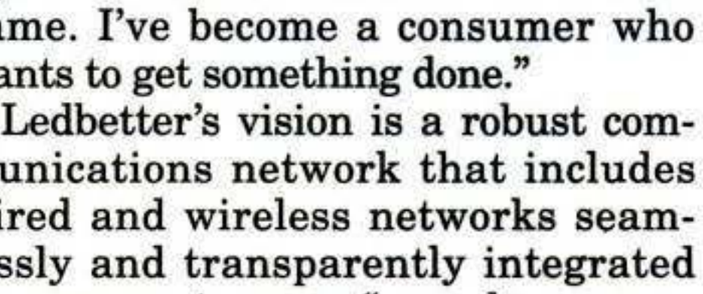
GARY BRAASCH

Digital Age meets log cabin: Senior Editor Dawn Stover aims her dish.

protagonist of the information and communications revolution now underway. For in his heart of hearts, Ledbetter is a "vicious consumer" in search of the ultimate information appliance.

"I'm often called a technical weenie," Ledbetter blushingly admits. "But I've watched my own transition to the point where I'm not interested in the technology for recreation. I've done that. I've built my own stereo components, I've built my own computer, and I used to find it fun. But I'm no longer willing to do all those things myself. Even though I like mechanical things, as the technology moves forward, the complexity becomes less intriguing. There comes a point when I don't want to have to look under the hood of my automobile. I just want it to run. It's a different game. I've become a consumer who wants to get something done."

Ledbetter's vision is a robust communications network that includes wired and wireless networks seamlessly and transparently integrated for anyone to use—"anywhere, anytime." At the sending and receiving end, we'll need new-generation communications products that are robust and smart enough to handle all the flavors of digital communications, yet easy enough to use as today's telephone. In an exclusive interview in this issue, Ledbetter provides a sneak peek at some of the remarkable projects that will point the way for this vision to become a reality.



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READERS TALK BACK

environment. Jews have been required to soak meats in saltwater before preparation for 5,000 years.

Arthur Stein
Albany, N.Y.

Unclassified At Last

D-21: The Supersonic Spy Drone" [Oct. '94] gave my family an official insight into what I secretly worked on 25 years ago. However, I'd like to clarify Ben Rich's statement that "Nobody had ever run a ramjet for more than just a minute or two" when work on the Drone idea began in 1962. In fact, the engine used in the D-21, a modified RJ43-MA20, had previously flown in the Bomarc B Interceptor mission for ten minutes at Mach 2.75 and 75,000 feet. The record for ramjets at the time was something over 30 minutes of flight, by the prototype Navaho Intercontinental Cruise Missile (later canceled in the 1950s by development of the ICBM).

James M. Southwell
Retired Marquardt
Propulsion Engineer
Canyon Country, Calif.

Readers interested in learning more about Lockheed aircraft projects will find a wealth of information in Jay Miller's Lockheed's Skunk Works, The First 50 Years, *available from Aerofax Inc. of Arlington, Texas (800-733-2329).—Stuart F. Brown*

A Matter Of Opinion

The CEO Channel is neither "ridiculous" nor is it about sitting around and watching hours of TV, as you imply in "Do You Really Need 500 Channels?" [Electronics Newsfront, Oct. '94]. Rather, it involves delivering information of relevance and importance at the time it is needed most, along with personality and insight into the management styles of those who run today's businesses.

Christopher Von Zwehl
The CEO Channel
Hoboken, N.J.

Old News

I chuckled when I read in Science & Technology Newsfront [Sept. '94] that recent studies show bacteria cannot adhere to meats in a high-salt

DNA Demystified

After reading many so-called explanations of DNA "fingerprinting," I didn't feel like I had a handle on the subject. Thank you for the great explanations of these complicated matters in "DNA Fingerprints on Trial" [Nov. '94].

Herb Bohler
Flemington, N.J.

Why Wait?

I disagree that readers "might want to delay making a commitment to the laser disc format," as you state in "The Next Generation of TV Sound" [Nov. '94]. As you point out, next-generation digital videodiscs won't be available until 1996 at the earliest. In the meantime, those who don't upgrade to laser discs will be stuck watching the lowest-quality video and audio available: VHS tapes. In 1998, when your writer is watching a degraded copy of *Jurassic Park* on an old VHS machine, I'll be enjoying my laser disc version, experiencing the same flawless picture and sound as I did when I first bought the movie.

Jay M. Auritt
Bensalem, Pa.

CBs In The Ozarks

I commute 360 miles round trip each week to the University of Missouri, Kansas City. My CB radio has saved me from countless delays and occasionally dangerous driving conditions. Here in the Ozarks, colloquialisms of CB radio talk are not passe [Electronics Newsfront, Nov. '94]. "Smokey" (police) is still around, as is "plain wrapper" (unmarked police car), "chicken coop" (weigh station), and many others. By the way, my "handle" is "Spittin' Kitten." Thanks, "Good Buddy."

Trudi Scott
Springfield, Mo.

Correction: Wacom's ArtPad featured in "What's New" [Nov. '94] costs $199 and responds to 256 levels of pressure.

Address your letters to Readers Talk Back, POPULAR SCIENCE, 2 Park Ave., New York, N.Y. 10016; fax them to 212-481-8062; or send electronic mail to our CompuServe account number, 75140,1732. The letters may be edited for space and clarity. Due to the volume of mail, we regret that we cannot answer unpublished letters.

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WHAT'S NEW

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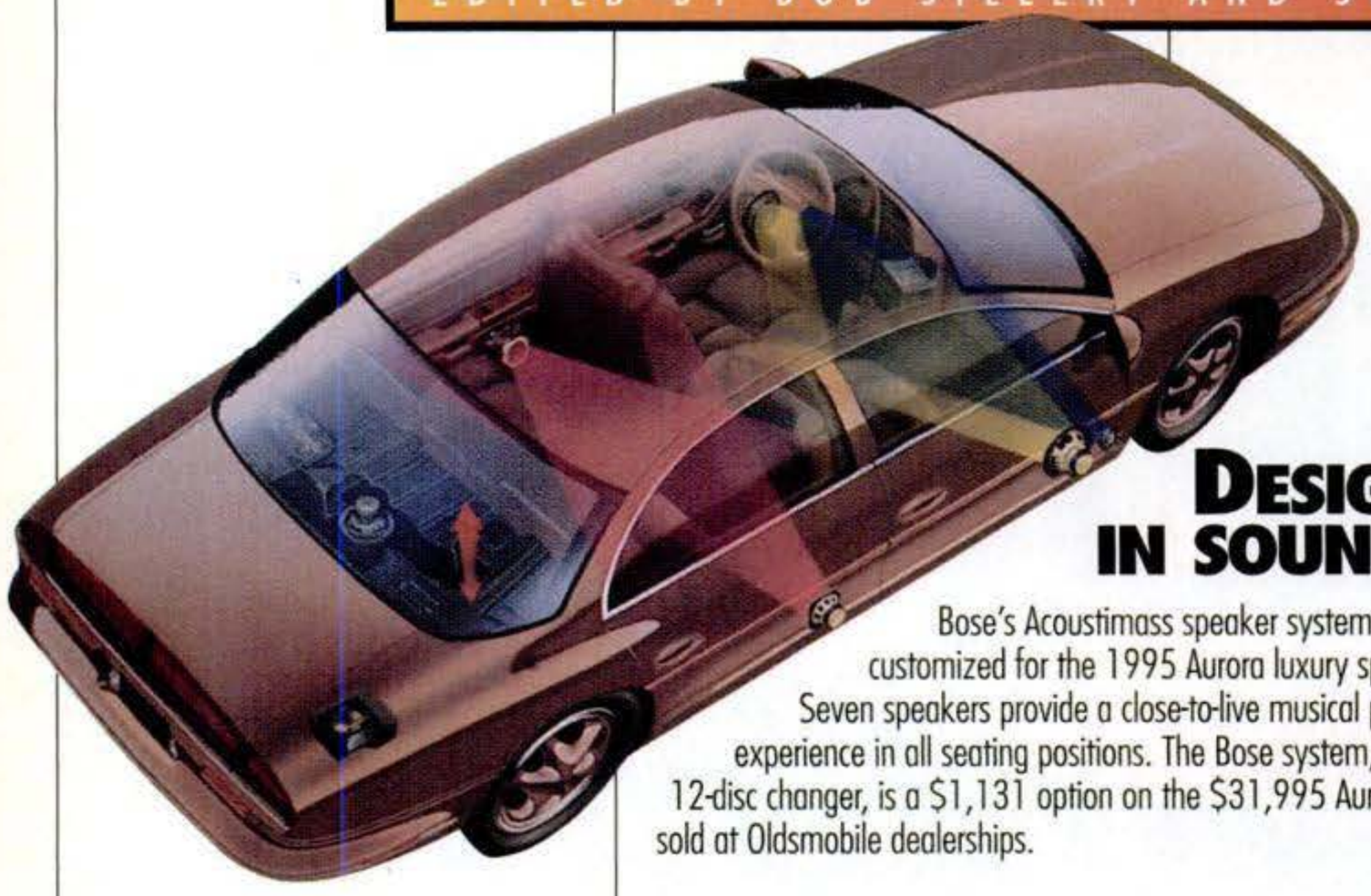


DESIGNED-IN SOUND

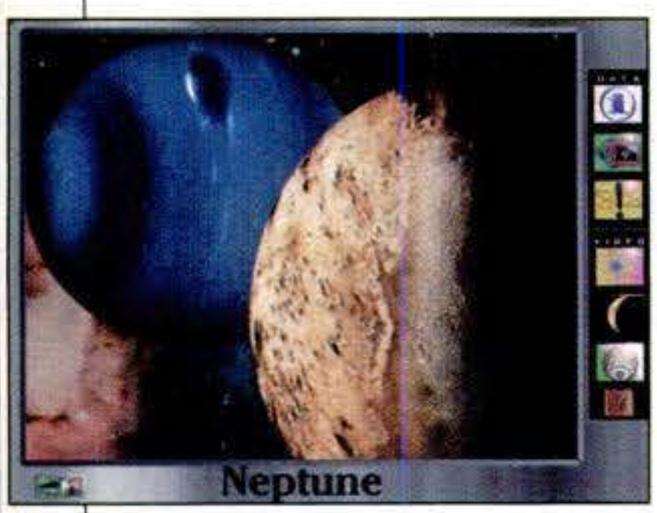
Bose's Acoustimass speaker system is accoustically customized for the 1995 Aurora luxury sports sedan. Seven speakers provide a close-to-live musical performance experience in all seating positions. The Bose system, including a 12-disc changer, is a $1,131 option on the $31,995 Aurora, which is sold at Oldsmobile dealerships.

ULTIMATE TRACTION

When mud, sand, or snow makes terrain nearly impassible, the Mattracks conversion system gives a four-wheel-drive pickup truck tanklike traction on all four wheels. Conversion takes 30 minutes with hand tools, says the manufacturer. The $15,000 system uses Kevlar-reinforced belts and a cogged drive. The 16-inch-wide track tread fits nearly all 4x4 models. National Transmission, 1436 Main Ave. N., Thief River Falls MN 56701.

STAR SPOTTER

Locating celestial objects is easy with this computer-driven telescope mount: Attach your tube assembly, load the astronomy software, and tell your computer what you want to see. The Archimage mount will find the object with a positioning accuracy that's comparable to some professional mounts. Dual positions let you mount two optical tubes at once. Price: $4,995. Merlin Controls Corp., Box 839, Berthoud CO 80513.

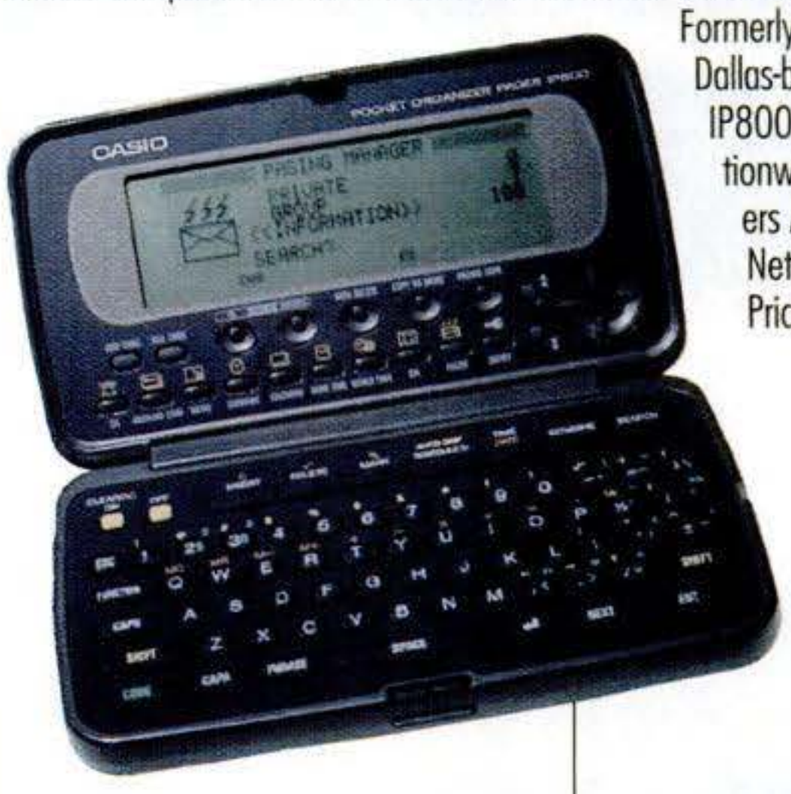


HEAVENLY VOYAGE

We have ignition. We have liftoff. With Voyage Through the Solar System, your computer with CD-ROM drive is your spaceship on a full-motion voyage throughout the heavens. For Macintosh or Windows PCs, the $50 disc includes photos and video from NASA and the Jet Propulsion Laboratory, as well as narration and music. Palo/Haklar Multimedia, 650 North Bronson St., Ste. 144, Hollywood CA 90004.

MESSAGE ORGANIZER

Anywhere, anytime wireless messaging is possible with the Casio IP800 pocket organizer with built-in alphanumeric pager. Incoming pages are automatically filed as business or personal. The 7.1-ounce unit runs for 400 hours on two AAA batteries. Formerly available only through Dallas-based PageMart, the IP800 can now be obtained nationwide through pager carriers AirTouch Paging, Paging Network, and MobileComm. Price: $299 to $349.



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SNAPSHOTS FROM VIDEO

Anyone who sees that picture worth a thousand words on a home video or television broadcast can now quickly capture it on Polaroid film with Sansui's VideoSnap. When you see a picture you like, press the Freeze button on the remote and the Print button to eject the photograph, which pops out in a second. The pictures are not quite as sharp as prints from a still camera, but for sending a family shot to a relative, they do nicely. Price: $600.

HELMETS THAT FIT

No two heads are shaped quite the same, so how do you find a motorcycle helmet that truly fits? Arai's Signet and Quantum/S models use several sizes of removable inner pads to tailor the fit to the noggin. Light weight, low wind noise, and an effective ventilation system are other benefits. Prices start at $340 and $422, respectively. Arai Helmets Ltd., Box 9485, Daytona FL 32120.

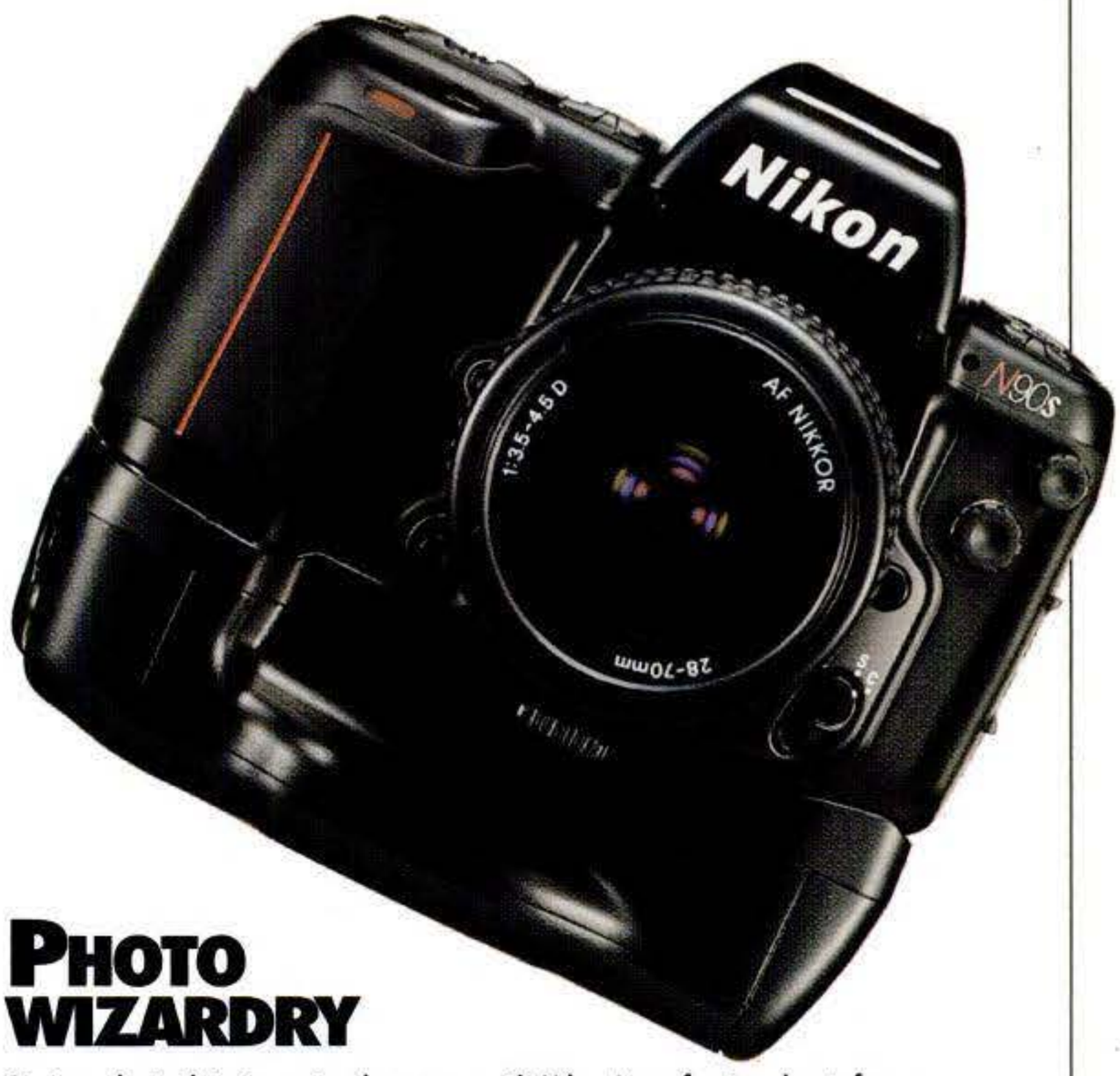

PHOTO WIZARDRY

Storing photo data is easier than ever with Nikon's professional autofocus SLR, the N90s. Using the company's AC-2E Datalink card, the photographer can record the roll and frame number, exposure, film and shutter speed, aperture, and focal length for as many as 35 rolls of 36-exposure film. This information can be downloaded to an 8000-series Sharp Wizard Electronic Organizer and then transferred to any Windows-compatible computer. Price: $1,210 (body only).

COMFORTABLE CONVERTIBLE

The 1995 Saab 900 convertible delivers the utility for which the car is renown: room for four adults, a rear seat that folds down to accommodate pass-through items from the trunk, and heated seats. The same no-nonsense approach applies to the drop-top: Snap back two latches, press a button, and it's down. A rubber inner layer protects the top while it's down, and tough exterior fabric keeps the weather out when the top's up. Price: $33,000 to $40,000.

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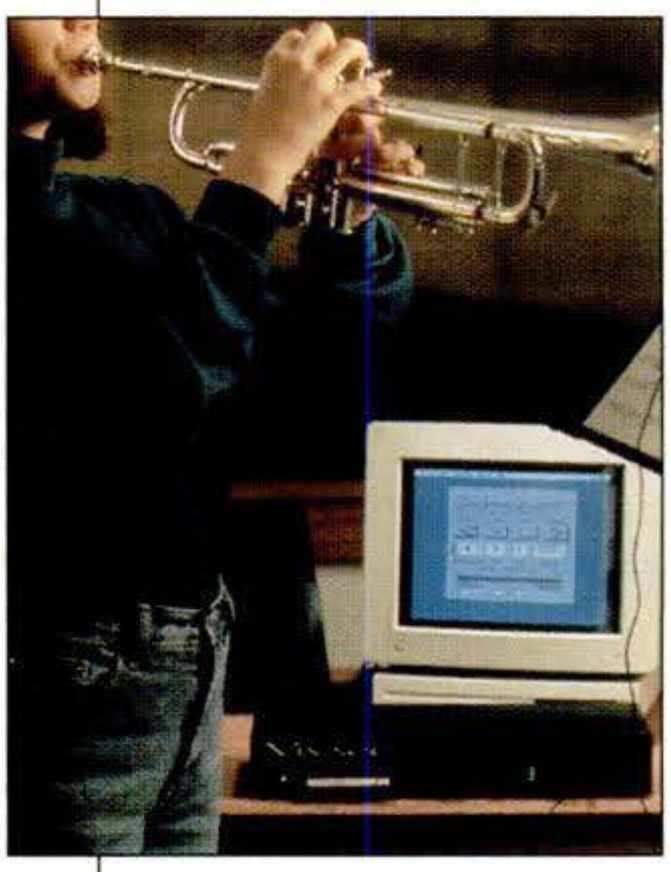
WHAT'S NEW



MULTIPURPOSE DIGITAL CAMERA

Barely larger than a golf ball, this tiny camera with built-in microphone takes stills, Apple QuickTime videos, and time-lapse pictures. The black-and-white camera plugs into a Macintosh computer serial port. The 3.6mm lens has a wide-angle, 65x view and can focus from 18 inches to infinity. Color versions of the camera for Macs and IBM-PC compatibles are expected this spring. Price: $150. Connectix Corp., 2600 Campus Dr., San Mateo CA 94403.

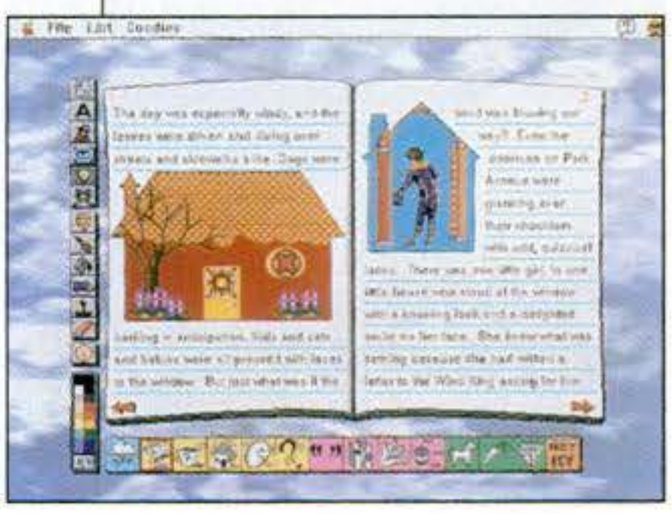
LIVELY INSTRUMENTALIST

An accompanist for brass and woodwind instruments, Vivace is an interactive partner that analyzes and reacts to a soloist's music as an orchestra or pianist would. The $2,295 unit works with Macintoshes, using cartridges that can be programmed to be attuned to how you play, repeat sections in loops, and track pitch. Cartridges start at $30 and include as many as 15 titles. A Windows version is expected soon. Coda Music Technology, 6210 Bury Dr., Eden Prarie MN 55346.

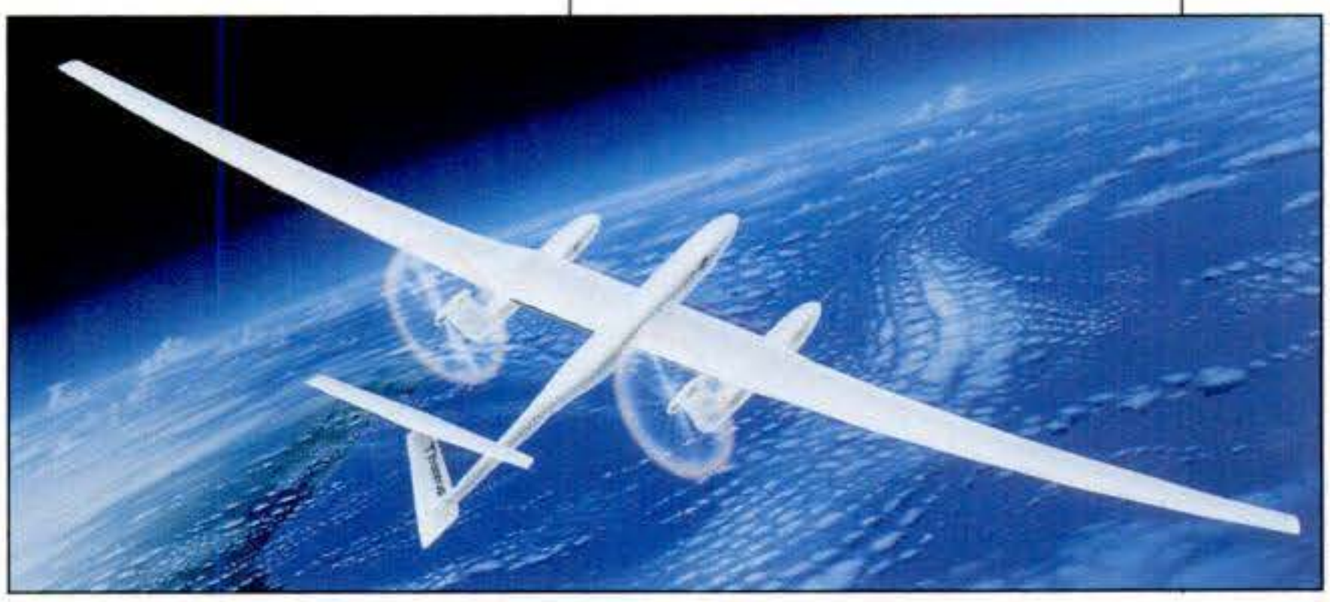
SPEED DEMON

At five pages per minute, the Canon BJC-4000 is the fastest color bubble-jet printer to date. This $549 printer outputs 360 by 360 dots per inch and 16.7 million colors. It uses two cartridges (one three-color cartridge and one black) to save the cost of replacing combination cartridges more frequently.

PRETEEN PUBLISHER



The Amazing Writing Machine (about $40) from Broderbund enables children ages six to 12 to write and illustrate their own stories, poems, essays, letters, and journals. The Macintosh program includes preformatted page templates and a Bright Ideas suggestion tool to help budding authors get started, and a broad selection of pictures, symbols, and stamps to help them enliven their pages.



ENVIRONMENTAL DRONE

Theseus is an unmanned aircraft that will cruise at an altitude of 16 miles, or about 85,000 feet, double-checking environmental data gathered by NASA's Mission To Planet Earth satellites. Scheduled to fly in June 1996, the craft is derived from the Perseus drone and uses two special supercharged-turbocharged engines designed to operate in the ultra-thin air at high altitudes. Aurora Flight Sciences Corp., 10601 Observation Rd., Manassas VA 22111.

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*Hi-Trac independent front suspension and 31" tires combined give you the highest ground clearance in its class.***

A. W. O. L.

You don't have to ask.

You get away on YOUR TERMS.

Because the TOYOTA 4x4 is all the permission you need.

With its AGGRESSIVE stance, and POWERFUL V6 engine,

there's no stopping you.

And since Toyota 4x4's "shift-on-the-move"

4WDemand means all four wheels are

ENGAGED with the flip of a lever,

you don't even have to stop to lock the hubs.

4x4x14

*Toyotas are the best-selling compact 4x4 trucks in America, and have been for the past 14 years.**

And when you're off on your OWN, it's good to know you've got Toyota 4x4's

reputation for DURABILITY and DEPENDABILITY

backing you up. TOYOTA. The #1-SELLING

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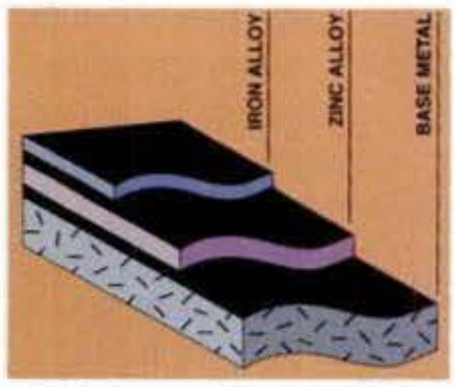


Multistep paint process helps keep body panels looking their best. Panels are phosphate-treated and PVC-coated with plastic and wax sealers; galvannealed steel and anti-chip paint help prevent rust.

Call 1-800-GO-TOYOTA for a BROCHURE and the location

of your NEAREST DEALER.

TOYOTA 4x4

I Love What You Do For Me

Toyota reminds you to *Tread Lightly!*™ on public and private land.
*R.L. Polk & Co. registrations through calendar year 1993. **With optional 31" tires.
©1994 Toyota Motor Sales, U.S.A., Inc. Buckle Up! Do it for those who love you.

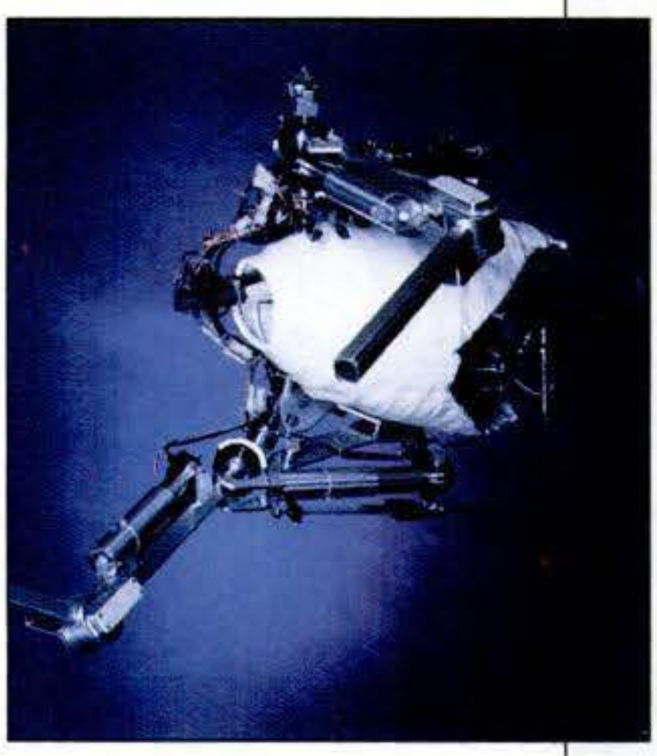
WHAT'S NEW

A BREATH OF AIR

When Volkswagen inserted the 2.8-liter, 172-hp V6 powerplant from the Jetta and Passat into the GTI, it breathed new life into the Golf III-based pocket rocket: The GTI reaches 60 mph in 7.5 seconds, tops out at 130 mph, and blasts through the quarter mile in just less than 16 seconds. Standard equipment includes air conditioning, power windows, cruise control, and an eight-speaker sound system. Prices start at $18,875.

ADROIT ROBOT

From astronauts' chef to interplanetary-base construction worker, the Robotic Surrogate delivered to NASA is ready to pull its weight in outer space. The robot's arms and shoulders move with humanlike adroitness and are being combined with preexisting wrists and hands, all designed by Ross-Hime Designs of Minneapolis, Minn. Because the robot limbs are powered electrically, not hydraulically, they aren't affected by the absence of gravity.



ELECTRONIC ROAD MAP

A personal tour guide of digital highways and backroads: That's how its creators describe Hitchhiking on the Information Highway CD-ROM for Windows PCs. This compilation of multimedia reference tools, instructional videos, and communications software includes trial accounts with major on-line services, and Netcom, Netcruiser (an Internet connection). Price: $100. Moon Valley Software, 141 Suburban Rd., Ste. A1, San Luis Obispo CA 93401.

JUMP START

Yanking on an engine's pull cord can get pretty tiring, pretty fast, so Homelite replaced the cord with an electric push-button starter on its new gas-powered string trimmer. The push-button system uses a rechargeable nickel-cadmium battery with enough juice to start the engine 40 times per charge. The trimmer features a two-cycle, 25-cc engine with an automatic choke and primer system. With a curved shaft, the trimmer is $169; with a straight shaft, $199. It goes on sale this spring.

DRY IN THE RAIN

A clever tread pattern; an innovative, long-wearing rubber compound, and ingenious internal construction propel the Pirelli P400 Aquamile all-seasons tire into a class by itself. The Aquamile boasts a T-rating (up to 118 mph) and an 80,000-mile warranty. Three deep channels dispel water while myriad zig-zag horizontal treads keep the tire firmly planted on the road.

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THE 1932 FORD V-8.

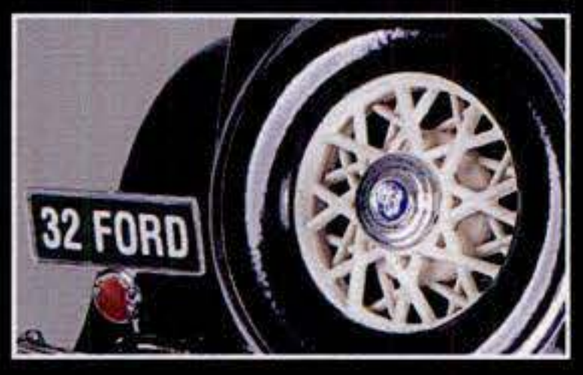
The Original DEUCE COUPE

Ford

Fully Authorized by
Ford Motor Company

Shown approximately actual size of
6¾" (17.15 cm) L. Scale 1:24.

The definitive die-cast model of Ford's first mass-produced V-8 coupe.
Precision engineered in 1:24 scale and packed with a full array of operating features.



It was born to roar. Powerful and Sleek. And, above all, notorious, the object of desire for three generations of the young and reckless. From the renegades of the 1930's to the rebels of the '50's and the street-rodders of today. More than 60 years after it burst upon the scene, it remains an American icon: the burning symbol of all that is wild, defiant and free.

The 1932 Ford V-8. The first of the famed deuce coupes. Now, the legend can be yours. In a spectacular die-cast replica every bit as exciting and alluring as the real thing. There's nothing else like it. Every memorable detail captured in 1:24 scale. From the radiator grille to the rumble seat. From the "ay-ooga" horn mounted to the front fender to the shrouded spare on the rear. Precision engineered to perfection. With such authentic operating features as doors that open and close, a rumble seat that opens, steering and road wheels that actually turn and a hinged hood that opens to reveal the intricately detailed V-8 engine. Assembled by hand from 165 separate components. The legendary '32 Ford V-8. Still cruisin' after all these years. Just $90, payable in monthly installments.

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If you wish to return any Franklin Mint Precision Models purchase, you may do so within 30 days of your receipt of that purchase for replacement, credit or refund.

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Franklin Center, PA 19091-0001

Please mail by January 31, 1995.

Please enter my order for the die-cast replica of The 1932 Ford V-8 Deuce Coupe.

I need SEND NO MONEY NOW. I will be billed in 5 monthly installments of $18.* each, with the first payment due prior to shipment.

**Plus my state sales tax and a one-time charge of $4.95 for shipping and handling.*

MR/MRS/MISS _____
PLEASE PRINT CLEARLY.

ADDRESS _____ APT. # _____

CITY _____

STATE _____ ZIP _____

TELEPHONE # (_____) _____

SIGNATURE _____
ALL ORDERS ARE SUBJECT TO ACCEPTANCE.

16244-72-001

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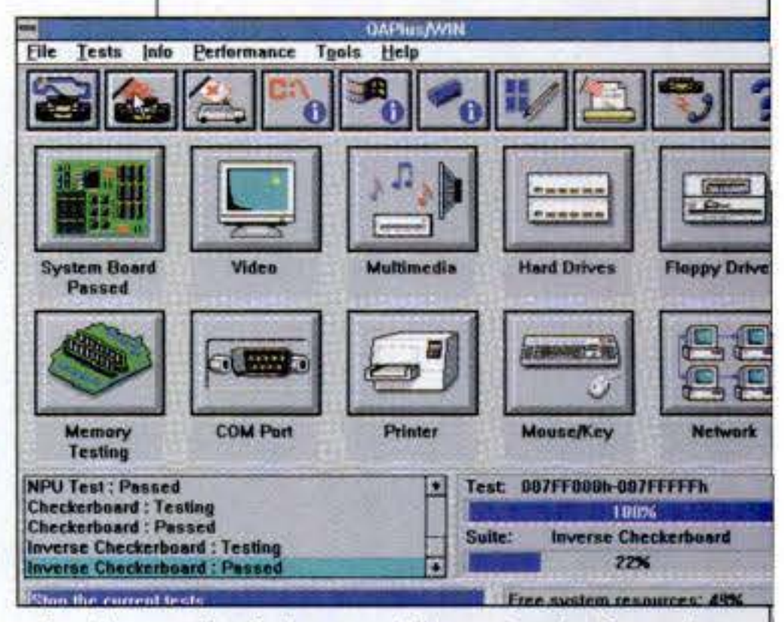
WHAT'S NEW

SLIM SHOOTER

Measuring only one inch wide, except for the handgrip, Ricoh's R-1 is the slimmest 35mm camera in the world—only the size of a roll of 35mm film keeps it from being thinner, says Ricoh. The $300 camera features two lenses—a 24mm superwide panorama and 30mm, which operates in panorama or regular mode—with seven-zone autofocus, a time/date stamp, and a self-timer.

VIRTUAL REPAIR



The doctor is in—and he's not stopping to chat. With software from Diagsoft, a technician can fix many computer problems remotely—in some cases, without needing to speak with you. QAPlus/Win 6.0 diagnoses your hardware; if it finds no problems, it asks for a description of the trouble. In most cases, your setup files will be sent out to a support station and returned, with fixes, via modem. Price: $100. Diagsoft, 5615 Scotts Valley Dr., Ste. 140, Scotts Valley CA 95066.

FROM HERE TO INFINITY

Nissan's Infinity division plans to introduce the I30 this spring as a 1996 model. The car is expected to feature a 3.0-liter V6 that generates 220 hp, antilock brakes, and dual air bags. The I30 may also employ Nissan's new "active damper" suspension, a cross between mechanical and electronic suspension, as a low-cost alternative to fully electronic suspension. The price is expected to start at about $30,000.

FOOTBRIDGE THAT TRAVELED

The 80-foot-long fiberglass bridge over the Staircase Rapids at Olympic National Park, Wash., is the longest composite bridge for pedestrians in the United States. Why use fiberglass to replace the steel span that was washed out in 1993? Steel would have required a helicopter lift that is illegal near the nesting sites of endangered bird species. The lightweight footbridge, by E.T. Techtonics of Philadelphia, was carried in pieces to the site by mule train.

TIMELY MESSAGES

Measuring only 1½ inches across—30 percent smaller than other pager watches—Seiko's MessageWatch delivers a pager's convenience while retaining a wristwatch's aesthetics. Its FM radio chip receives voice-mail notification, local sports scores, and other data, and self-adjusts 36 times a day to the U.S. Bureau of Standards atomic clock. The watch comes in several styles and colors and costs about $80, plus a $11 monthly service charge. Seiko Communications of America, 1625 NW AmberGlen Ct., Ste. 140, Beaverton OR 97006.

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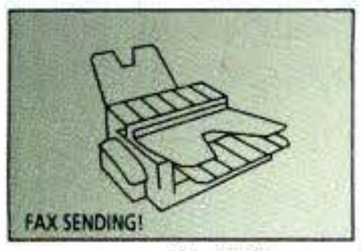
THE NEW WIZARD OZ-9520FX.

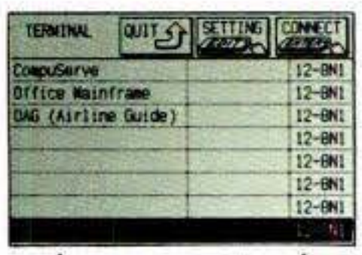
(IT WOULD BE EASIER TO TELL YOU WHAT IT DOESN'T DO)

It's the latest addition to the #1 selling line of personal information organizers. It features a pen-based graphical user interface, 512K of



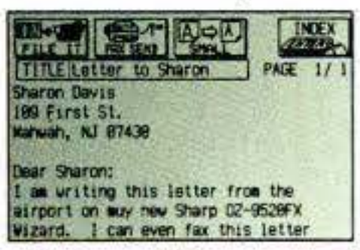
memory and all the tools you could ever want in a 10.5 ounce package. And the new "ultra-compact fax modem" only adds 1.27 ounces and requires no additional cables or setup for use. Best of all, it can remain attached to the Wizard and still fit in a pocket or purse.

The unit's built-in fax software permits users to send a drawing, a letter, or even an entire folder of documents. The software also provides a speed-dial directory and automatically creates a cover sheet for outgoing faxes. By entering the terminal mode the OZ-9520FX uses ASCII or VT-100

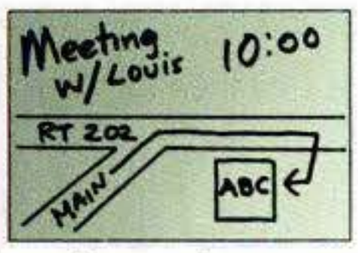


emulation to send and receive electronic mail and connect to on-line services like CompuServe®.

A word processor with cut, paste, and a variety of text styles enables you to produce professional-looking letters. Completed documents can then be beamed to a colleague's Wizard or output wirelessly to a PC-compatible printer with the optional infrared adapter.

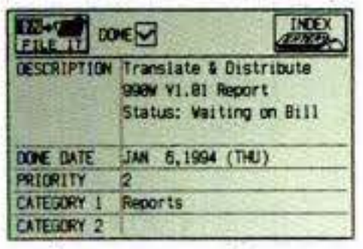


Scrapbook allows you to draw and store hand-written words or maps and diagrams

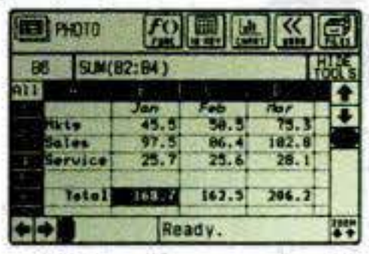


directly on the screen using the Wizard's stylus or your finger. Images can also be imported from a PC or Mac® into Scrapbook enabling telephone entries, for example, to have portraits or maps attached to them. A unique Filer system–of graphically represented folders–groups related information together by subject, making it ideal for project management.

And when it comes to time management, Wizard sets the standard. Four different calendar views, 3 phone directories, a To Do list, and there's even a function that allows you to enter annual events, like birthdays and anniversaries, so you'll never miss a moment.



The Wizard is your virtual office. No matter where the day takes you, creating a spreadsheet is as easy as inserting the optional PenCell® spreadsheet card.



Using Computer Link software, data can be transferred to and from a PC or Mac®. And the optional wireless adapter enables Wizard's infrared technology to make this transfer effortless.

And if you ever have any questions there's even a built-in tutorial with explanations and diagrams for every function. But, until you get one, fax us at 1-800-74-SHARP. We'll answer your questions about the OZ-9520FX and tell you about our high-end OZ-9500 and OZ-9600II series. Or call us at 1-800-BE-SHARP and we'll help locate your nearest dealer. It's just about the only thing this Wizard can't do for you.

THE NEW WORKPLACE™

WIZARD® Carried By The Most Organized People On Earth.

SHARP®
FROM SHARP MINDS COME SHARP PRODUCTS™

LCD

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CORDLESS TELEPHONES • TYPEWRITERS • WORD PROCESSORS • WIZARD® ORGANIZERS

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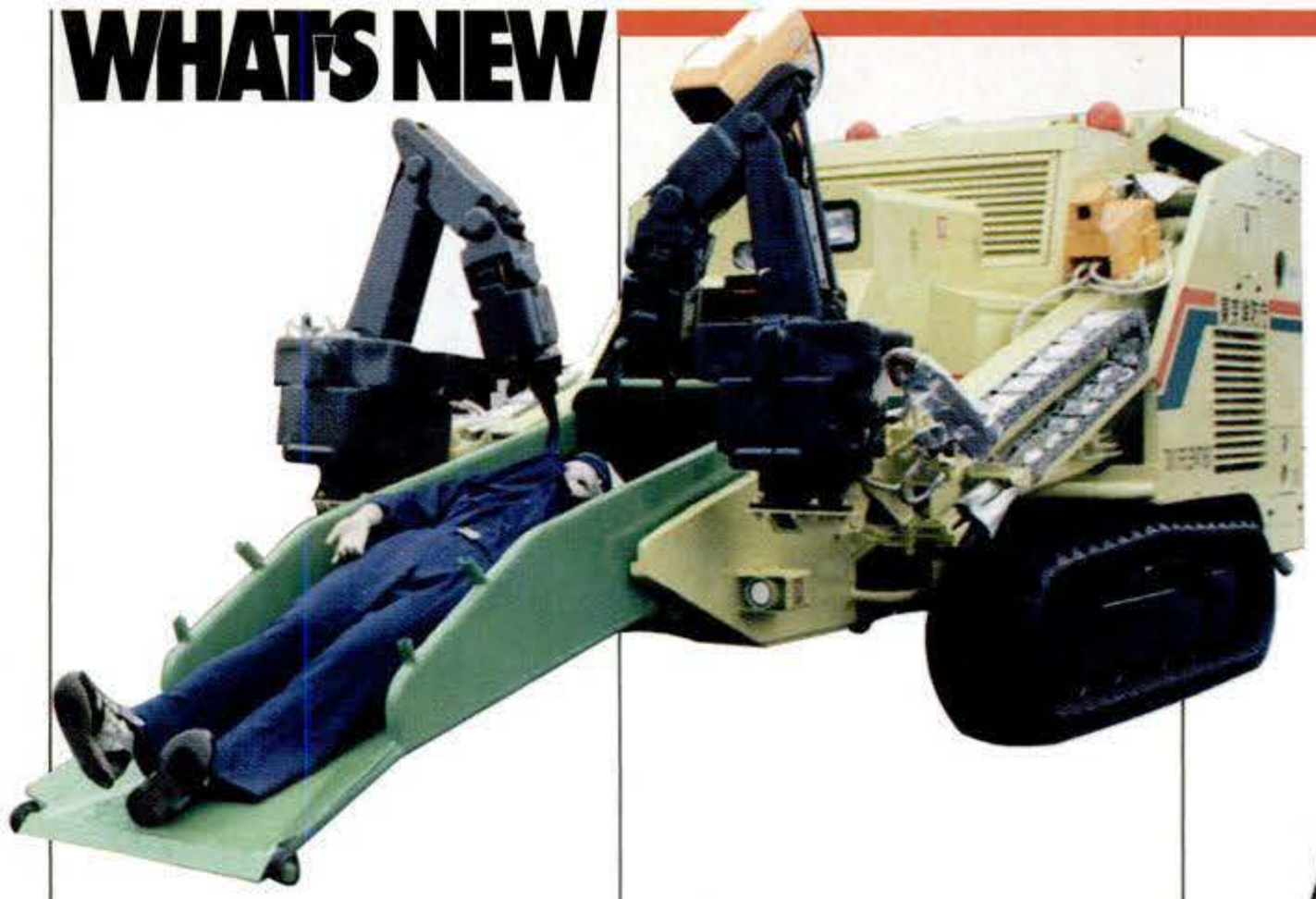


ROBOT TO THE RESCUE

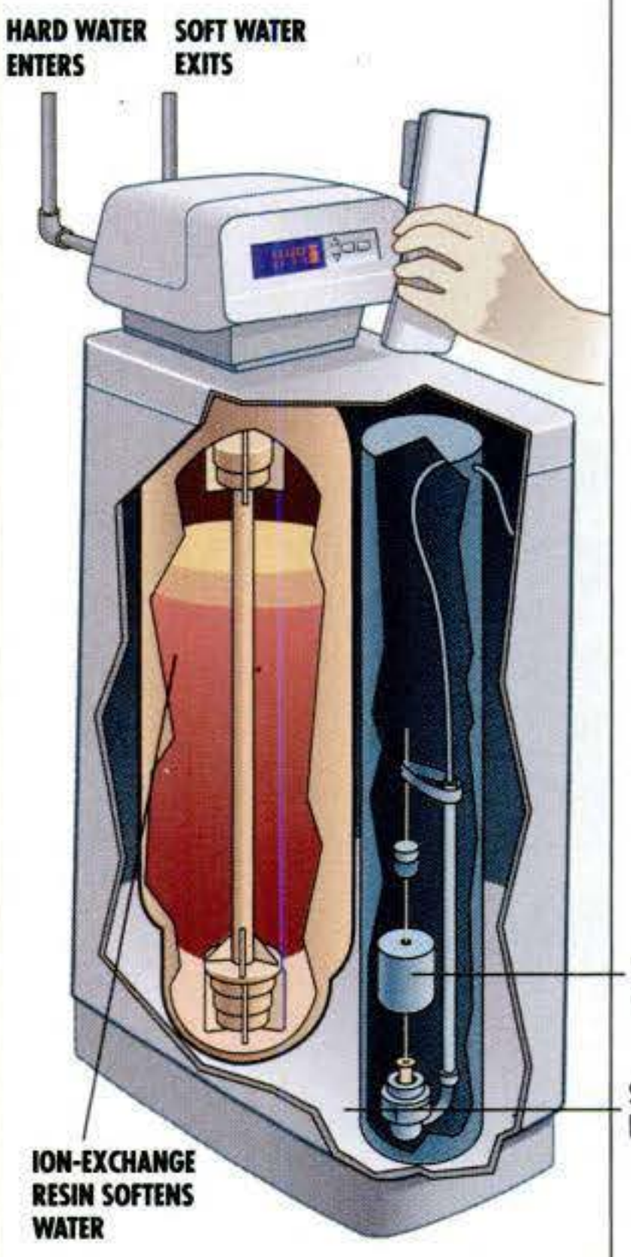
In Tokyo, victims trapped in a burning building may raise a call for Robokyu—a word formed from robot and rescue. Designed for dangerous rescues, Robokyu is teleoperated up to 300 yards away from a truck-mounted control panel using video and infrared cameras and ultrasonic sensors. Its arms can lift unconscious victims onto a stretcher. Robokyu was developed at a cost of $1.9 million by the Tokyo Metropolitan Fire Department and industrial equipment maker Aichi Corp.

SOLAR PHONE BATTERY

With SolarLife, Motorola cellular flip-phone users can talk and recharge the battery at the same time. This first-ever solar-rechargeable cellular telephone battery replenishes itself through sunlight, so there's less reason to worry about turning it off to save the battery. The price should be comparable to that of non-solar batteries. Models for other phones are under development. Bel-Sound Inc., 377 Rt. 17 S., Hasbrouck Heights NJ 07604.

AUTO-BRUSH

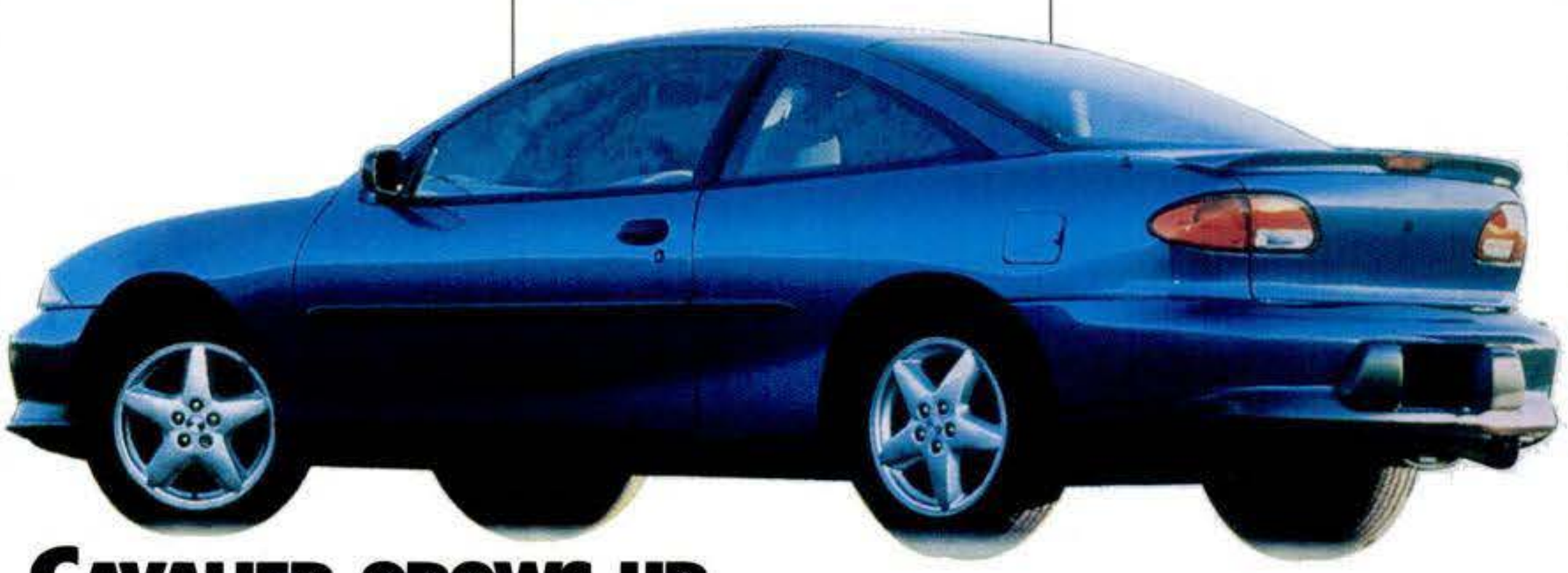
For proper brushing technique, just bite the Oralgiene's brush head and this electric toothbrush will do the rest, claims its maker. Two outer circular brushes are automatically angled for positioning under the gumlines, while two flat brushes clean the grinding surfaces of top and bottom teeth. Price: $80. Oralgiene, 10920 Wilshire Blvd., Los Angeles CA 90024.



STEVE STANKIEWICZ

SMART SOFTENER

The Series 3000 updates conventional ion-exchange water softening with computer technology. The result is a reduction of as much as half the salt and water of other softeners, claims the manufacturer. A microchip monitors household water usage, predicts future usage, and programs itself for maximum efficiency. The chip also enables service diagnosis over the phone. Installed cost: about $1,600. EcoWater Systems, Box 64420, St. Paul MN 55164.



CAVALIER GROWS UP

Chevy's 13-year-old Cavalier becomes sportier and roomier in its first complete redesign. While the Cavalier retains the 2.2-liter (or optional 2.3-liter) engine, its wheels have been moved forward and outward, providing more passenger room. A new "coil over shock" suspension softens bumps, and new engine mountings are designed to quash vibrations. Prices start at $10,545 (coupe) and $12,950 (LS sedan).

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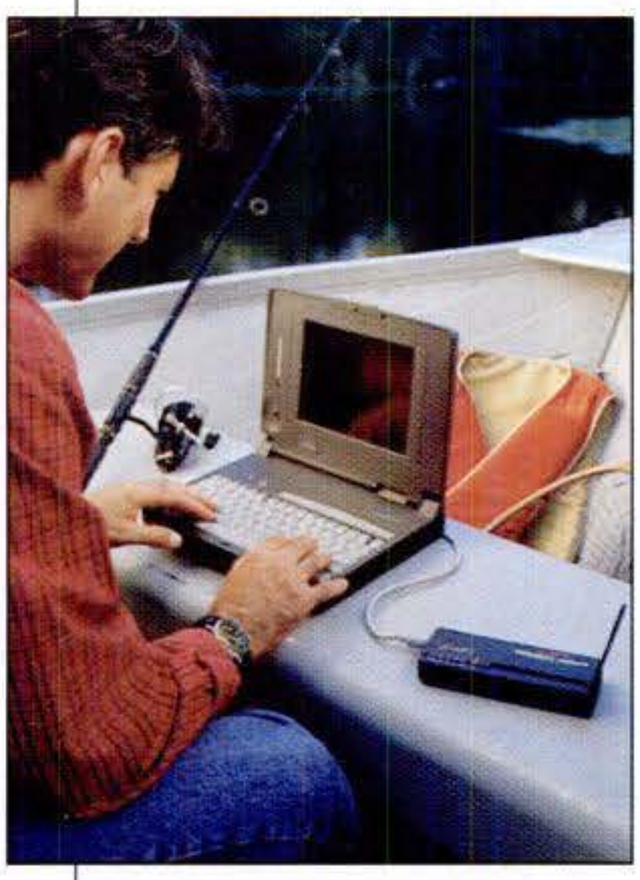
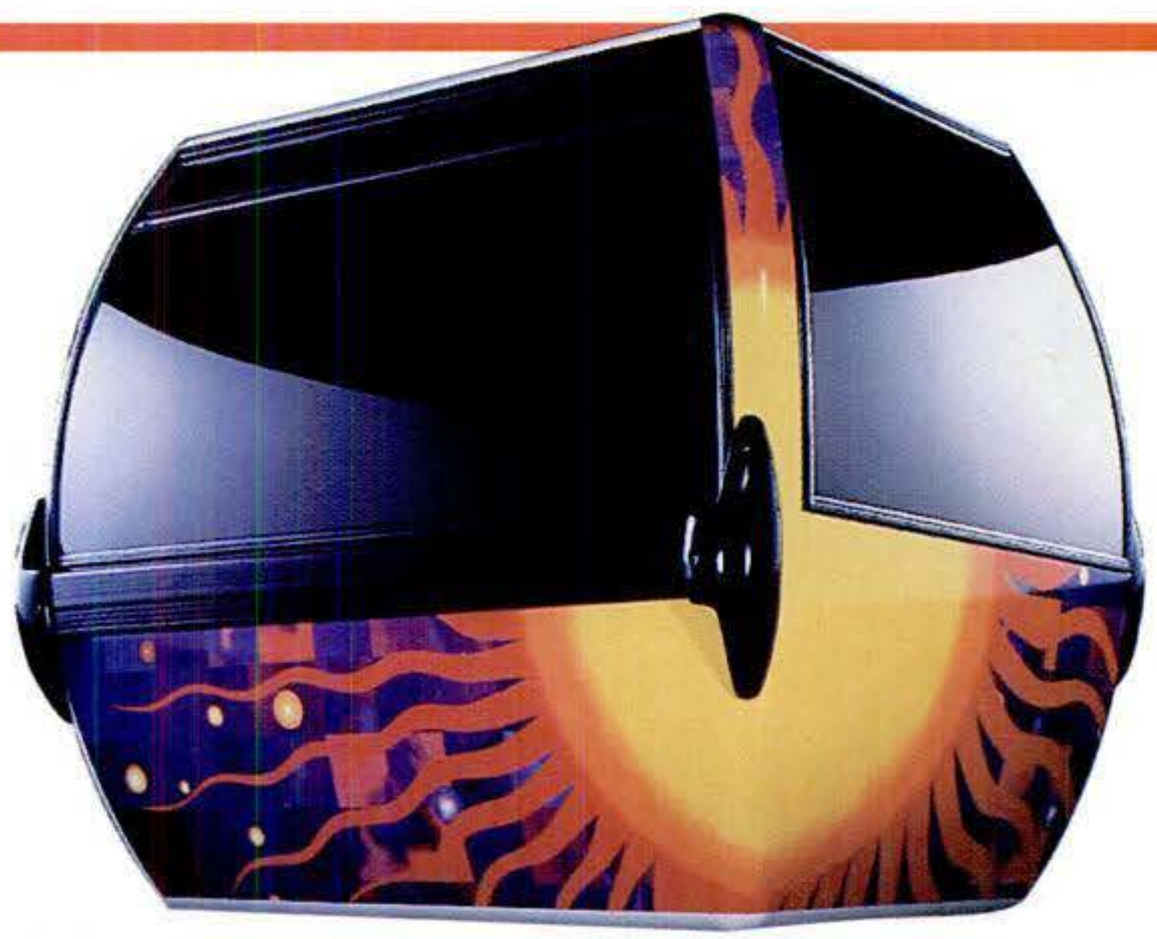
MULTI-MODE MODEM

The PocketPlus, the smallest wireless modem, offers two wireless options: circuit-switched cellular or the less noisy Cellular Digital Packet Data (CDPD), which should be widely available by the end of this year. It also has an RJ-11 jack for landline communications. Two AA batteries provide 1.5 hours of talk time for switched cellular and 12 hours for CDPD. Price: $1,195. Sierra Wireless, #260, 13151 Vanier Pl., Richmond BC, Canada.





TOASTIER TOES

You won't have to run into the ski lodge at Killington, Vt., to warm up this winter. Just hop on the Skyeship, the first gondola-lift system with heated cabins. A self-contained kerosene heater inside each eight-passenger cabin will maintain an ambient temperature of 50°F. The lift will travel 2.5 miles to reach the top of the ski area's 3,800-foot-high Skye Peak in 12.5 minutes.

RAINBOW SHIP

Despite a gloomy supercar market, the British have designed a high-priced, high-speed two-seater with hopes that perhaps there is a pot of gold at the end of the rainbow. The GTD R42 runs on midship-mounted American muscle from the 4.6-liter V8 used in the Lincoln Continental. GT Developments of Dorset, England, claims the modified engine pushes the car to 60 mph in less than four seconds. Price: from $84,000 to $104,000.

CUSTOM PLAY

Have you ever shot down an elephant with an exploding daisy? With Klik & Play you can. This Windows software lets you create your own games, where the boundaries of reality pose no limitation. Use your mouse to select and animate objects, create games, and add sound effects. Twenty ready-to-play games, which you can also modify, are included. Price: $55. Maxis, 2 Theater Sq., Orinda CA 94563.

BIRDERS' DELIGHT

Nikon's new Diplomat line sports three features unusual in lightweight, compact binoculars: aspherical lenses for reduced distortion, a diopter adjustment that can be locked in place so it doesn't need resetting, and eye relief that's long enough to give the user a full field of view even while wearing eyeglasses—ideal for birdwatchers. The price of the 8x23 model is $338; the 10x25 model is $378.

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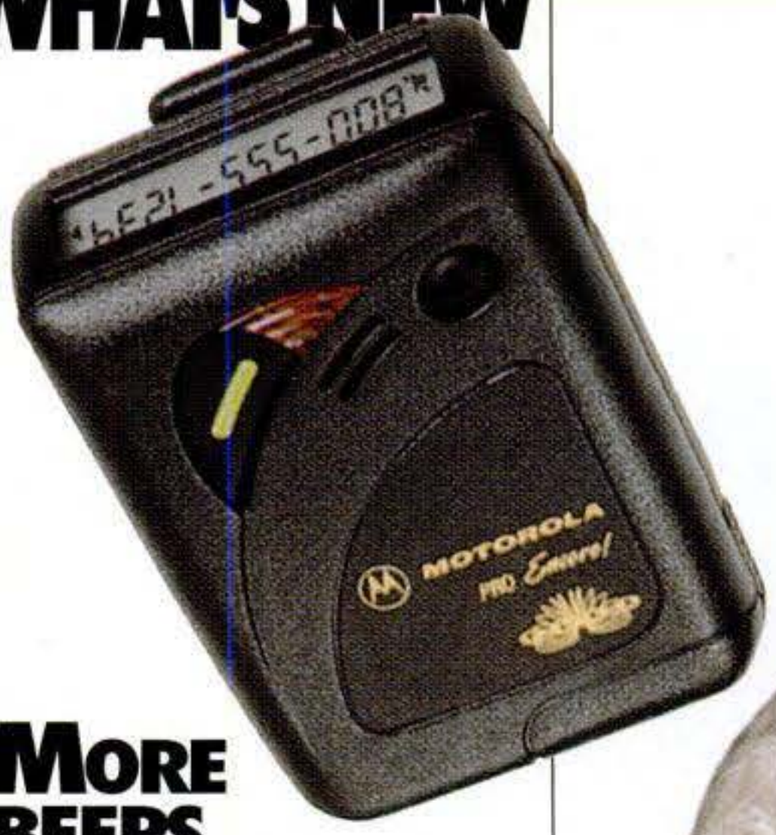
WHAT'S NEW

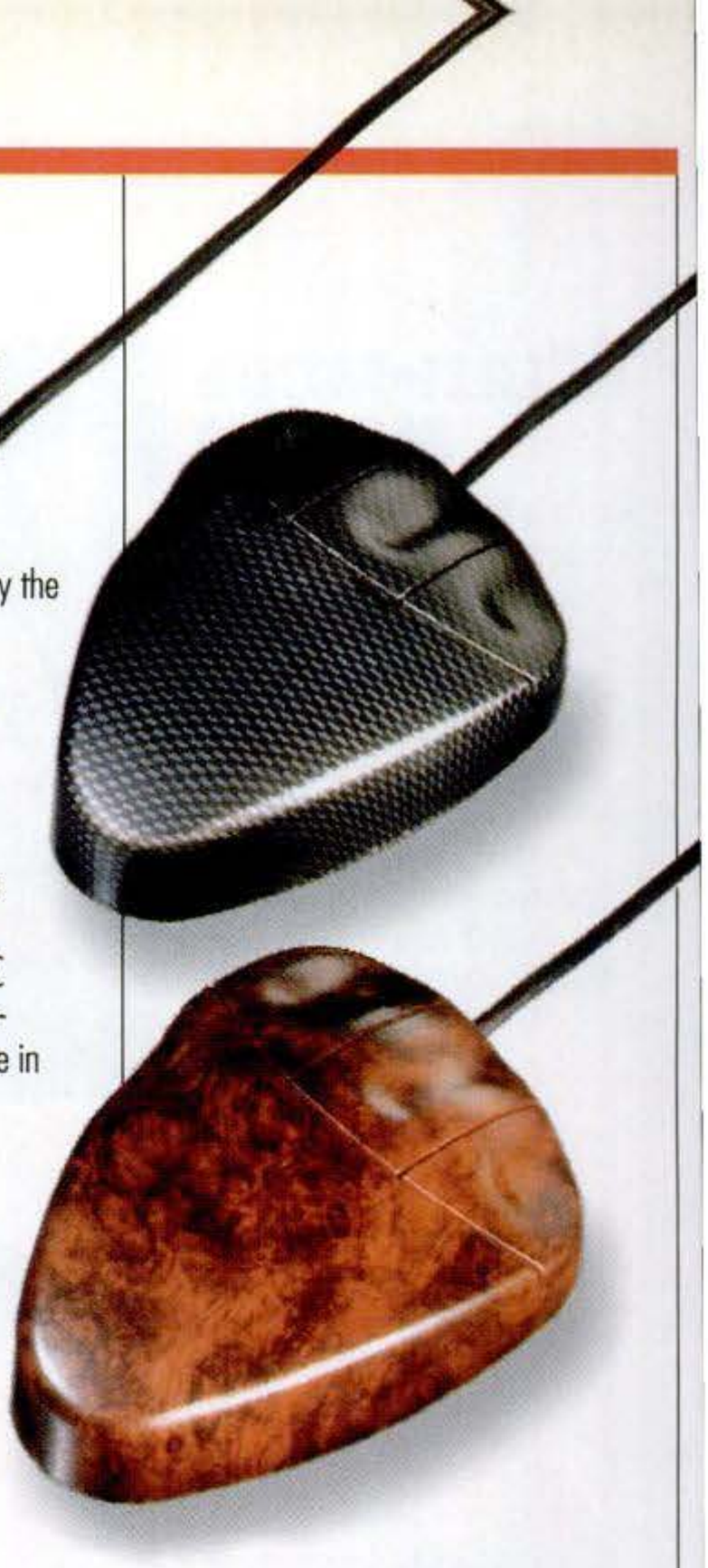


MORE BEEPS PER BATTERY

Motorola's Pro Encore numeric pager operates for 160 days, or five times longer than other pagers. Its extended battery life is an immediate benefit of a new high-speed data-transmission protocol called Flex, which will be used to support future advanced paging services and products such as two-way paging. Price: $195.

HIGH-TONE MICE

You say the practical gray and beige color of your computer hardware doesn't express the real you? The distinctive patterns and textures of Logitech's line of Sensa mice may add some pizzazz to your PC workspace. The stylish, ergonomic input devices come in four colored patterns and two finishes: glossy and suede. Price: $75.



MONSTER 'COASTER

The world's steepest slope (60 degrees) and biggest vertical drop (177.8 feet) hurl riders to a top speed of 71 mph on the new Titan rollercoaster at the Space World amusement park in Kitakyushu, Japan. Designed by Arrow Dynamics of Utah, the three-minute ride includes a series of boomerang curves. The $30 million rollercoaster was named after the NASA rocket, in keeping with the park's space theme.

SPORT, ITALIAN STYLE

There's nothing like the feel of wind in your hair at 130 mph, easy work for the Alfa Romeo Spider introduced in Europe this year. The Italian automaker offers three engine choices for the stylish front-wheel-drive pop-top: a twin-spark version of a Fiat 2.0-liter 16-valve engine that delivers 150 hp, a 2.0-liter V6 turbo with 202 horses, or a 3.0-liter V6 that produces 230 hp. No word yet on whether the Spider will migrate to America.

JAPAN'S FIGHTER

Prototypes of the new FS-X fighter plane derived from the American F-16 are being built for Japan's Self Defense Agency by Mistubishi Heavy Industries and Lockheed Fort Worth Co, the first cooperative development program of this scope ever carried out with Japan. The U.S. Defense Department says it's making sure the deal isn't a one-way flow of technology and work to Japanese companies.

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For a free product brochure call 1-800-950-2438. *Leather seating surfaces available in Extended Cab only. †Always wear safety belts, even with air bags. **Dependability based on longevity: 1984-1993 full-line truck company registrations. Excludes other GM divisions. The Chevrolet Emblem is a registered trademark and Chevy is a trademark of the GM Corp. ©1994 GM Corp. All Rights Reserved. Buckle up, America!

Better Take This News Sitting Down.

Better fasten your safety belt, too. Because the Chevy Full-Size Pickup has an all-new interior. Its form-fitting seats are more comfortable than ever. Leather seating areas are

even available if you feel like indulging yourself. The instrument panel is easier to read and easier to use. The*

*optional center console is kind of our answer to the Swiss Army Knife. And, of course, there's a standard driver's-side air bag.† Don't worry. The Chevy Full-Size is still built like a rock. It just doesn't feel that way. Chevy. The most dependable, longest-lasting trucks on the road.***

Chevy Trucks
LIKE A ROCK

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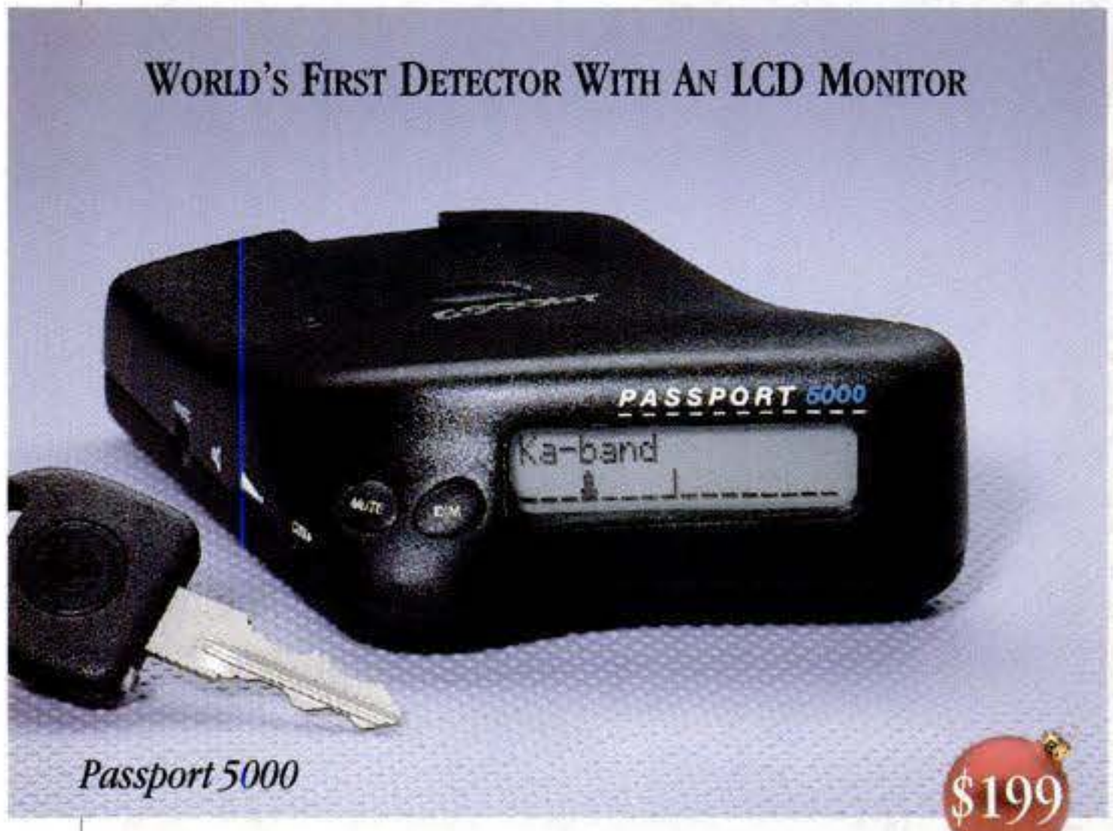
This holiday, delight your favorite driver with the latest technological breakthroughs from Escort. Our radar/laser detectors offer cutting edge technology second to none: Passport 5000 is the first detector with an LCD monitor for complete information display. Solo 4 is the first cordless *radar/laser detector for unparalleled convenience.*

If you want to give the best, give Escort.

WORLD'S FIRST DETECTOR WITH AN LCD MONITOR



Passport 5000

$199

- World's first detector with an LCD monitor displays radar/laser information at a glance.
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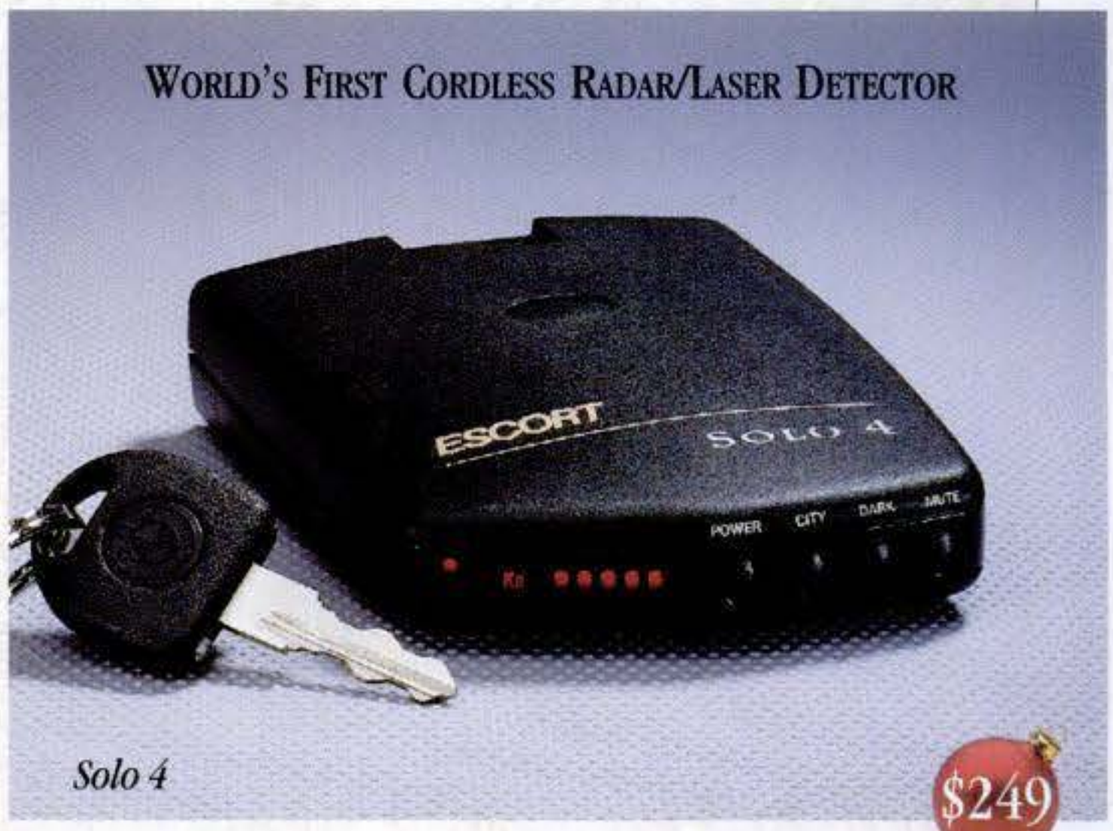

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SCIENCE & TECHNOLOGY

EDITED BY DAWN STOVER

ENVIRONMENT

REPAIRING THE OZONE LAYER

A giant electrified curtain hanging far above Earth could help restore the planet's protective ozone layer, says plasma physicist Alfred Y. Wong of UCLA. His proposed curtain would neutralize chlorofluorocarbons (CFCs) that are destroying ozone.

In the atmosphere, chlorine atoms break off from CFCs and attack ozone molecules. Wong's idea is to give the chlorine atoms a negative charge, so they no longer react with ozone. In laboratory tests, the idea appears to work.

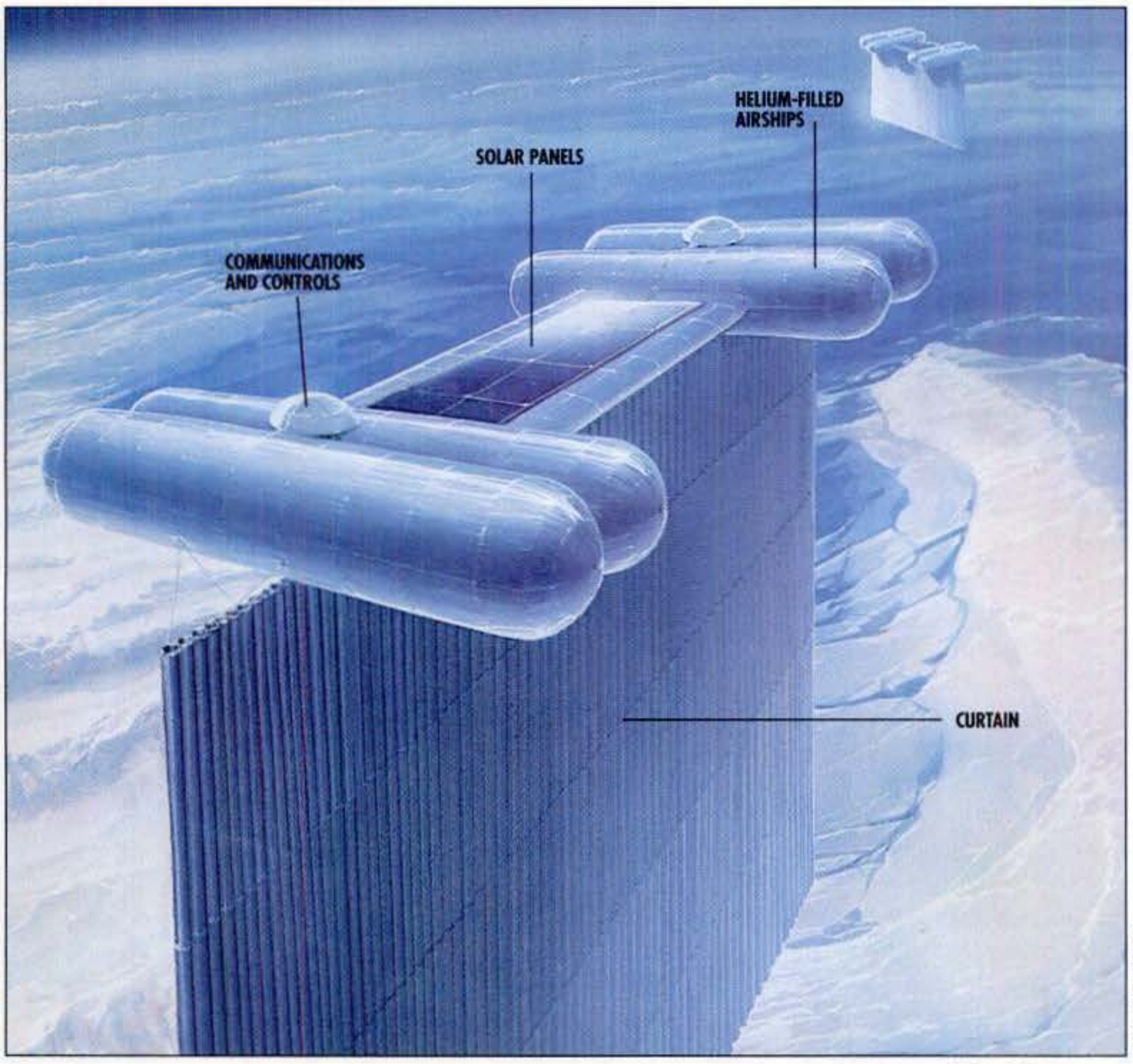
To negatively charge chlorine atoms in the atmosphere, Wong proposes constructing massive wire curtains that would hang from blimps. Powered by solar panels, the curtains would spit out electrons to charge passing chlorine atoms. Once charged, the chlorine atoms could be collected on a second, positively charged curtain, or on a curtain doped with an element such as sodium that would bind with the chlorine to form salt.

Wong is also looking at cagelike designs made from wires or thin metal tubes. "Our objective is to make it as light as we can," he says.

The curtain or cage could be suspended in the stratospheric ozone layer. Or it could hang closer to Earth in the troposphere, where it would eliminate some CFC molecules before they drift high enough to threaten ozone.

Wong plans to build a small-scale curtain that will fly on NASA's SR-71 Blackbird research airplane. Sensors on the plane will take ozone measurements before and after the curtain is deployed. Another experiment may focus on repairing ozone holes created by rocket launches.

The task of removing chlorine atoms is not as difficult as it might seem, says Wong. There are relatively few of these atoms in the atmosphere, but each one can destroy as many as 500,000 ozone molecules.



ROBERT MURRAY

This electrostatic curtain gives chlorine atoms a negative charge, rendering them incapable of destroying ozone molecules. The solar-powered, football-field-size curtain would be carried aloft by airships.

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AVIATION

REAL-TIME WEATHER

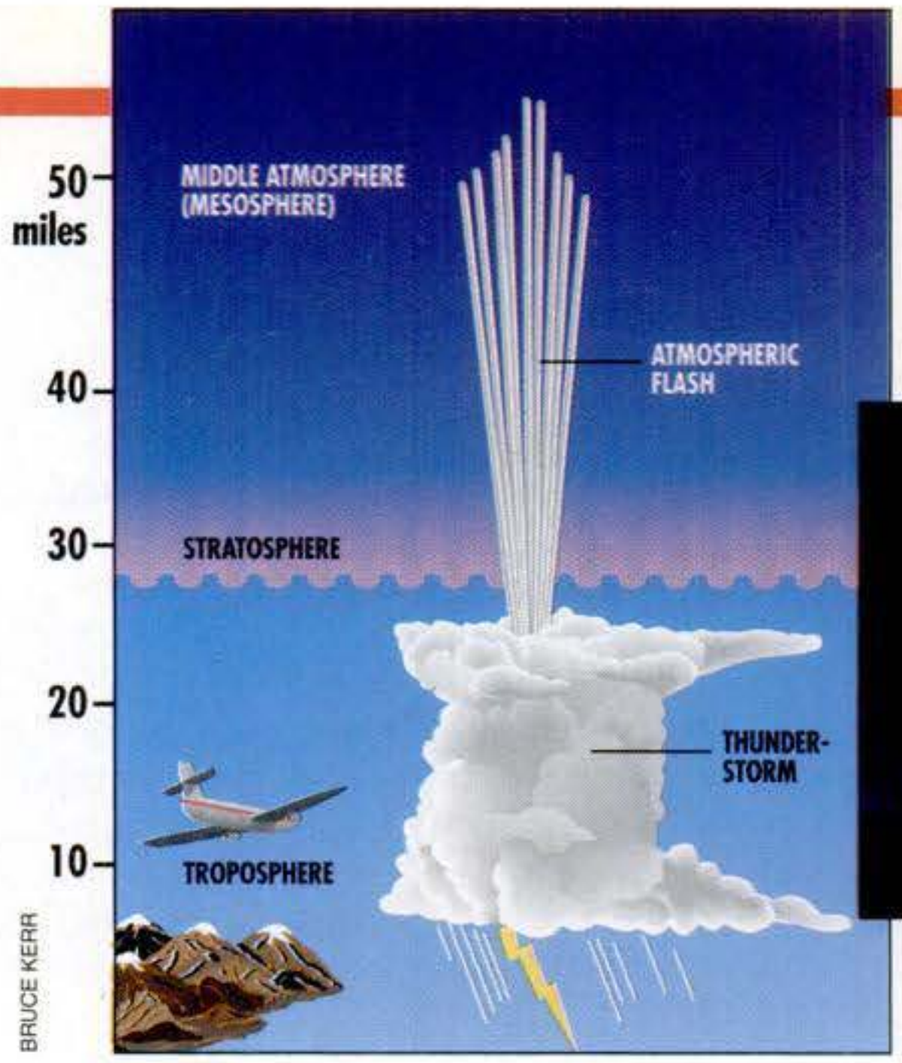
As seasoned travelers know, bad weather can turn an airplane flight into a bronco ride or prevent a plane from landing on time. While pilots can't change the weather, they can stay better informed with two new information systems.

One system, developed at NASA's Langley Research Center, creates maps of storms and lightning activity; these maps also contain the aircraft's flight path and alternative routes. Transmitted to a cockpit computer, the maps are compiled from ground-based radar data.

Another, potentially faster system feeds directly on satellite data. The system uses a personal computer and software from Lockheed to match weather data with latitude and longitude overlays. A flat-topped omnidirectional antenna mounted on the fuselage receives the satellite signals.

The Lockheed system may initially be used on research flights over the North and South poles, where weather data is scarce. NASA has already demonstrated a DC-8 outfitted with the equipment on a polar flight.

Eventually, commercial airliners may be equipped with such weather-on-demand systems. Because they allow pilots to map out the best routes around storms, these systems could cut an airline's operating costs by $18 million a year, NASA engineers estimate.
—Judith Anne Gunther



BRUCE KERR

Mystery flares: Atmospheric flashes like the one in the photograph below dance above thunderstorms for a fraction of a second, then vanish.

DANIEL OSBORNE

SPACE

UNIDENTIFIED FLASHING OBJECTS

You are looking at a legitimate UFO—an unidentified flashing object. This "red sprite" is one of a slew of mysterious flashes observed above thunderstorms recently. No, scientists don't think it's a signal from an alien visitor, but they're not sure what produced it.

In a series of flights over the Midwest this summer, a University of Alaska team videotaped more than 500 unusual flashes above thunderstorms—verifying previous reports of such phenomena. In addition to the red sprites, which look like Roman candles and stretch as high as 90 kilometers, researchers have also photographed "blue jets" that shoot up from cloud tops like geysers.

The sprites are the same color as the northern lights (an atmospheric effect caused by electromagnetic pulses from space), so scientists theorize that the sprites might be triggered by storm-generated electromagnetic pulses that tear electrons from molecules in the middle atmosphere. This theory, however, does not explain why sprites appear in bunches with tendrils of color trailing out from them. And the blue geysers are downright baffling. "We have no explanation for them," says Eugene Wescott, who led the University of Alaska expedition.

The next step, says Wescott, is to investigate whether the unexplained flashes occur in the tropics, Earth's thunderstorm hotbed. If so, scientists will have to reevaluate their long-held dogma that the middle atmosphere is an uneventful region of the sky.
—Robert Langreth

CHEMISTRY

PLASTIC SOLUTION

Recipe for plastic: Dissolve a spoonful of chemical building blocks called monomers in a cup of organic solvent. Add a pinch of initiator compound to make the monomers bind together in long chains called polymers. Pour polymers into mold, harden, and serve.

The problem with this recipe is getting rid of the leftovers. A new method devised at the University of North Carolina at Chapel Hill solves the problem by replacing organic solvents with nontoxic "supercritical" carbon dioxide.

Already used to decaffeinate coffee, supercritical CO_2 is a highly pressurized gas that is almost as dense as a liquid. A surfactant keeps polymers dissolved in the CO_2 while they grow into long chains. The pressure is then lowered to release the gas.

THE OCEANS

SHRIMP'S EYE VIEW

Researchers exploring the deep sea in the submersible *Alvin* have found that "black smokers"—chimney-shaped vents that release hot gases and minerals along cracks about 3.5 kilometers below the ocean surface—also release their own light.

The light is too weak to be seen with the naked eye but shows up in long-exposure photos of the smokers. Researchers are still sorting out the possible sources of the light, including crystalloluminescence (light produced by the crystallization of chemicals), triboluminescence (light emitted when particles bump into one another), Cerenkov radiation (light caused by the radioactive decay of elements released from the vent), and burning methane.

Another contender is blackbody radiation, similar to the red glow produced by molten iron. No one has studied blackbody radiation under such deep, watery conditions. But one species of vent shrimp, *Rimicaris exoculata*, may give a clue. "We now know what the structure of the [shrimps'] eyes looks like," says Steven Chamberlain of Syracuse University, a researcher on many of the *Alvin* dives. "This animal has a veritable 'wall' of photosensitive membranes, about 60 to 70 percent of its retina—just right to see the dim light from blackbody radiation."

Researchers are now studying other organisms that live near deep-sea vents. They're searching for any one-celled, photosynthetic organisms that use the vents as a light source. Such a find could significantly change our ideas on evolution: It could mean that photosynthetic organisms evolved in the ocean's depths before making their way to shallow water.
—Patricia Barnes-Svarney

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WASTE CONVERSION

OLD SLOP MAKES NEW FUEL

It looks like mere garbage: piles of slippery peelings left over from vegetable canning, spent grains from brewing beer, and watery whey from making cheese. But these and a variety of other organic wastes can be converted to a methane-rich fuel gas, using a process developed by researchers at Battelle's Pacific Northwest Laboratory in Richland, Wash. The new process is faster, more efficient, and less expensive than previous methods.

In the Battelle process, a slurry of organic waste is pressurized to 3,000 pounds per square inch and heated to 350°C as it passes over a bed of nickel catalyst. In less than ten minutes, the catalyst triggers a reaction that turns the waste into a gas that is about 50 percent methane, 45 percent carbon dioxide, and 5 percent hydrogen. This gas contains about 525 Btu per cubic foot, enough energy to fuel industrial boilers. The carbon dioxide can be separated for bottling, packaging, and other plant operations. Waste heat is recovered and reused.

Other methods for processing high-moisture waste require energy-intensive drying. Also, these methods are slower and do not completely convert lignin, a component of plant cell walls.

Lab researchers have collaborated with Onsite*Ofsite of Duarte, Calif., to construct a trailer-mounted demonstration system. It is now being tested on sugary waste from the soft-drink industry.—*Mariette DiChristina*

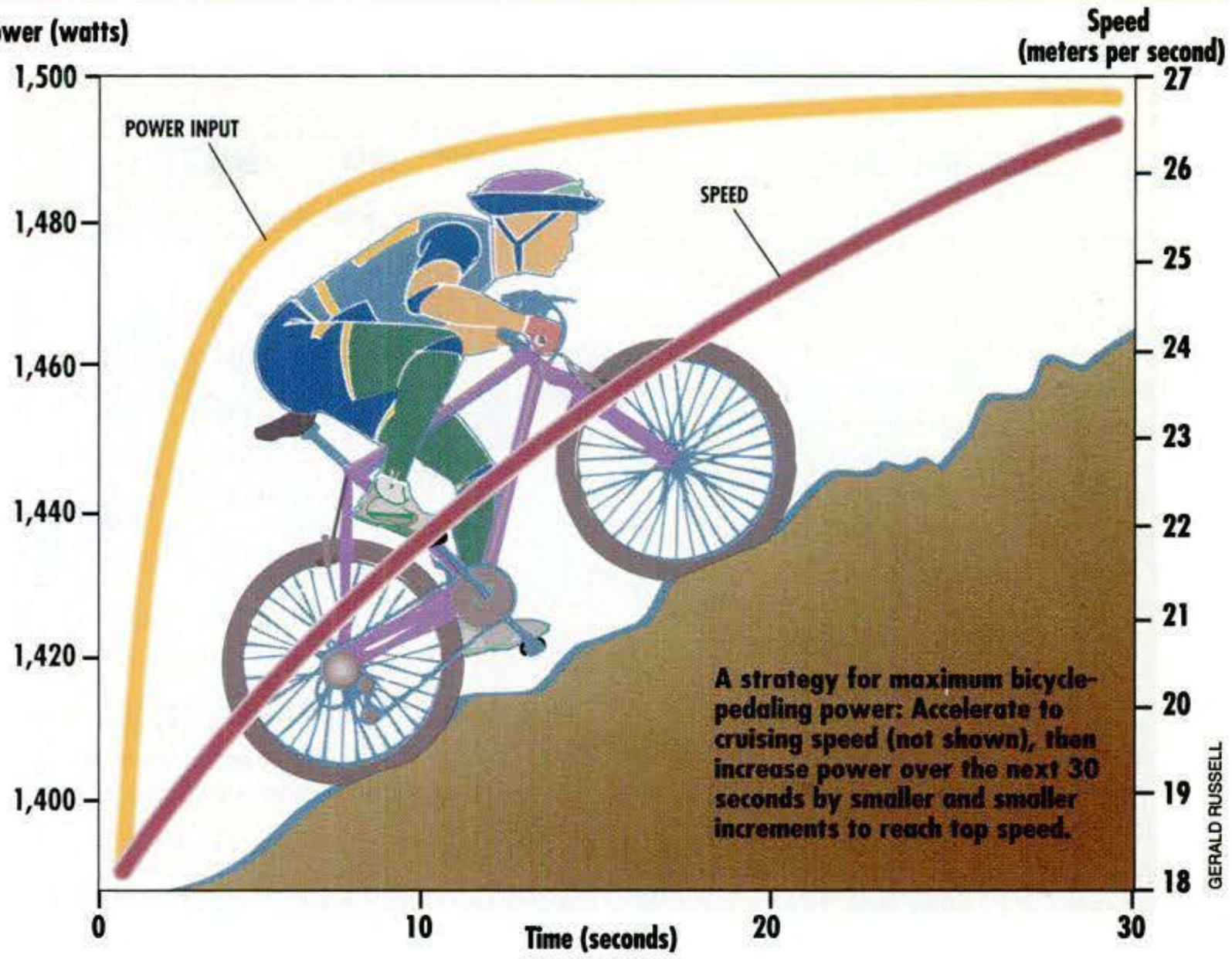
ENVIRONMENT

PET DETECTIVES

University of Illinois veterinary researchers have found a new way to test children for lead poisoning: Take blood samples from their pets.

The researchers measured lead levels in the blood of 84 dogs and 26 cats in Granite City, an Illinois town contaminated by a smelting plant. When the scientists compared their results with blood tests of children living in the same area, they found a strong correlation. High lead levels can cause mental damage in children.

Pets—especially dogs—pick up lead from contaminated soil and dust. "If your dog doesn't have a high level, you can be almost 90 percent confident that your household is safe," says Louise-Marie Cote, one of the researchers.



BIOMECHANICS

STRATEGY FOR CYCLING SPEED

Kids pedal their bikes as hard as they can for as long as they can in order to go as fast as they can. A good idea for kids, maybe, but not for anyone attempting to set a serious speed record.

Racers need more than power pedaling—whether they're merely seeking a personal best or challenging the world's mark for two-wheeled, human-powered vehicles: 68.73 mph.

Doug Boyer, a graduate student in applied mechanics at California State University in Chico, has developed a strategy to help riders maximize their speed. Using a mathematical representation of a human-powered vehicle, Boyer controls the pedaling strategy of a simulated cyclist until the vehicle's speed peaks. The model takes into account how much energy the body can produce at one time, as well as the total amount of energy the body can expend during a given period of physical activity.

Boyer's model involves a two-part power input strategy. First, the rider accelerates the vehicle to a speed he can maintain without tiring. In the second stage, the rider increases the power—initially by a large amount, but subsequently by smaller and smaller increments.

Using Boyer's strategy instead of the one they learned as kids, bicycle riders may break more speed records, and may even go beyond 70 mph. —*William L. Thieriot*

AVIATION

MORE THAN SKIN DEEP

When engineers design an airplane, the placement of communication and navigation antennas is often an afterthought. These antennas can significantly affect the plane's aerodynamics, however. Researchers at Wright-Patterson Air Force Base and several aviation and electronics companies are working together to circumvent this problem by layering antennas into structural panels for reduced drag and better performance.

The antennas are coiled into panels 30 to 40 inches across; each panel performs between five and ten functions. These functions range from surveillance and target acquisition in military aircraft to high-definition television reception and satellite communications in commercial jets. With conventional antennas, these systems require separate circuitry. But in the new panels, a single circuit board processes data for all of the antennas. The researchers claim that the antennas will provide more comprehensive information because of increased processing power and the sharing of data.

When a conventional antenna malfunctions, it must be replaced. Not so with a panel that is an integral part of the aircraft. The panels are constructed with redundant parts: If one part fails, its functions can be rerouted to another. —*Suzanne Kantra*

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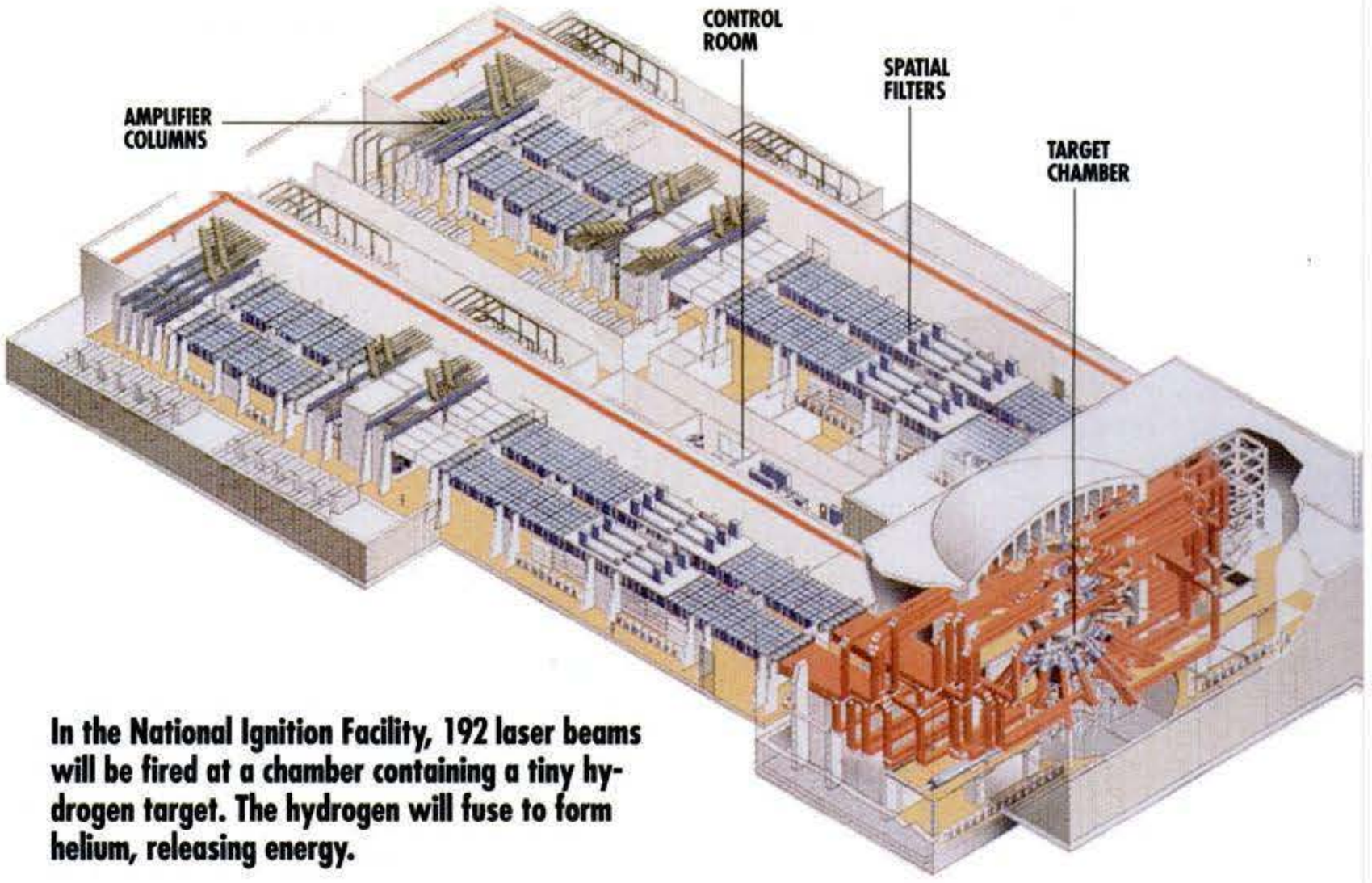
PHYSICS

LASER LAB

Lawrence Livermore National Laboratory has won a major victory in its battle to stay alive: The Energy Department has chosen the nuclear-weapons lab as the construction site for a stadium-size machine that will generate miniature thermonuclear explosions. Called the National Ignition Facility, or NIF, the machine will not only help astrophysicists study the nuclear reactions within the sun and other stars, it will also keep the nation's top bomb designers in fighting form.

The NIF, which will be jointly managed by Livermore and two other weapons labs, will contain the world's largest and most powerful laser. This laser will emit 192 beams of intense light that will bounce back and forth between amplifying mirrors before converging on a pea-size target of hydrogen fuel, heating it to 50 million°F.

To ensure that the target is heated uniformly, it will be housed in a gold cylinder called a *hohlraum* (German for hollow room). Laser beams entering the *hohlraum* will vaporize it, creating a plasma so hot that it emits X rays. These X rays will in turn bombard the hydrogen target, fusing it into helium and releasing energy. If this energy is sufficient to trigger additional fusion reactions, scientists will have achieved a milestone known as ignition.



In the National Ignition Facility, 192 laser beams will be fired at a chamber containing a tiny hydrogen target. The hydrogen will fuse to form helium, releasing energy.

Before this type of fusion can become feasible for commercial power production, researchers will have to learn how to implode a hydrogen target not just once but about ten times every second—just as an internal-combustion engine must fire repeatedly to keep a car running. But even if the NIF does not prove useful as a power source, it will help scientists study the processes that fuel stars and nuclear bombs.

The project will keep a cadre of nuclear physicists employed for years—and close at hand if they are needed to design future weapons. But some experts say the NIF could send the wrong message to other countries that have agreed to ban nuclear testing, and Energy Secretary Hazel O'Leary has called for a study to resolve the dispute.

If Congress gives its approval, construction will begin next year. The NIF is expected to cost $1.8 billion over its 15-year lifetime.

AVIATION

SHOWING RESTRAINT

The U.S. Army and Navy are drawing on automotive technology to prevent injuries to helicopter crews. The Inflatable Body And Head Restraint System, or IBAHRS, uses two inflatable nylon bags inside the vertical straps of the seat harness to limit body movements in a crash.

Helicopter crashes can cause injuries when bodies collide with cockpit structures, or when impacts to the back, buttocks, and thighs transmit energy to internal organs. Energy-attenuating seats in Black Hawk and Apache helicopters have helped reduce injuries, but the harnesses in these aircraft don't always keep aviators upright in their seats. Even with a tightly fastened harness, an aviator can slide under the straps and slam into the control stick or other obstacles.

IBAHRS holds the crew member upright in his seat by pulling the harness straps tight and spreading friction over the chest. Triggered by an omnidirectional crash sensor, sodium azide gas generators inflate the harness bags in about 35 milliseconds. Unannounced actuations in a simulator left crews surprised but still able to fly.

The Army tested the system last summer on the aging AH-1F Cobra helicopter at Fort Rucker, Ala. The two-seat Cobra is an attractive place for IBAHRS because of the big telescopic sighting unit in the front gunner's cockpit. Once in Cobra fleets, the system is expected to find its way into other helicopters. The Navy is currently testing it for the newer Marine AH-1W.

Phoenix-based Simula built the IBAHRS prototype. The company is under a separate Army contract to design cockpit air bags.—*Frank Colucci*

Inflatable harness straps keep crews upright in their seats.

GLOBAL WARMING

COCKROACHES COUNT

Atmospheric concentrations of methane are rising, but scientists have yet to identify or quantify many of the sources of this potent greenhouse gas. Dutch biologists Johannes Hackstein and Claudius Stumm maintain that a number of methane-producing animals have been overlooked in global inventories.

In particular, they argue, contributions from bugs and insects should be reassessed. Their studies suggest that cockroaches, millipedes, and beetles may produce roughly the same amount of methane as termites, which are already considered a significant source. All told, these arthropods may emit between 10 billion and 300 billion kilograms of methane annually. The total estimated global methane release is 500 billion kilograms a year.

The biologists base their calculations on studies of 150 arthropod species. The tally does not include methane produced by cockroaches living indoors.—*Steve Nadis*

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ENGINEERING

SMART GUN

The U.S. Justice Department has asked Sandia National Laboratories to design a gun that can only be fired by its owner. The primary goal of the research is to prevent law enforcement officers from being shot with their own guns.

To design the new gun, Sandia is using sophisticated defense technologies, including some originally developed to ensure the security of nuclear weapons. The lab expects to have prototype "smart guns" ready for law enforcement agencies to test in 1996.

Sandia project manager Douglas R. Weiss says his team is investigating a wide range of gadgetry. For example, a smart gun could communicate via radio signals, acoustic waves, lasers, infrared light, or ultraviolet rays with a tag worn by its owner.

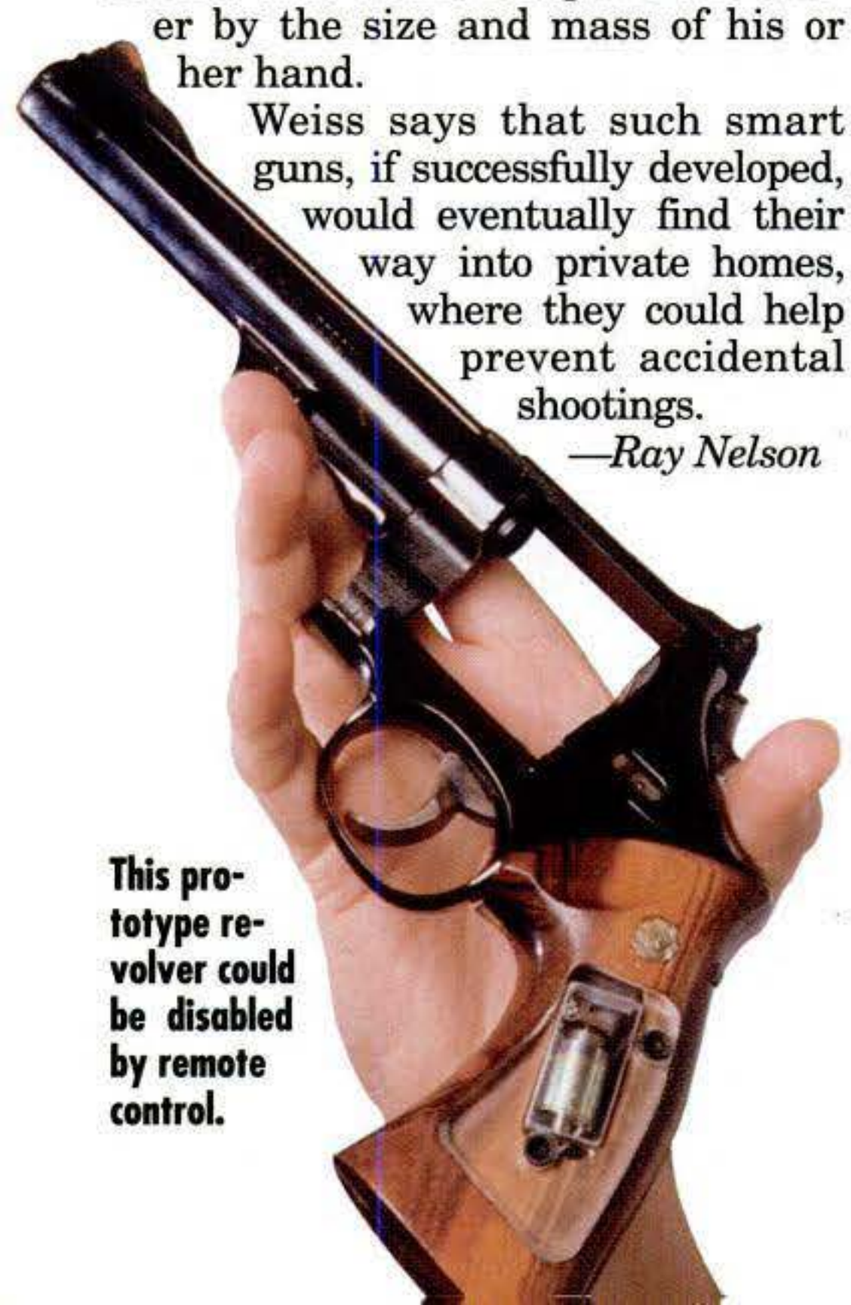
Houston-based Fulton Arms has already developed a modified .357 revolver that will fire only when its custom-fitted handgrip comes in contact with a magnetic ring worn by its owner. The gun goes on sale soon and will cost at least $1,000.

A prototype Sandia revolver takes a slightly different approach, using a remote control to send encoded radio signals to a receiver inside the handgrip.

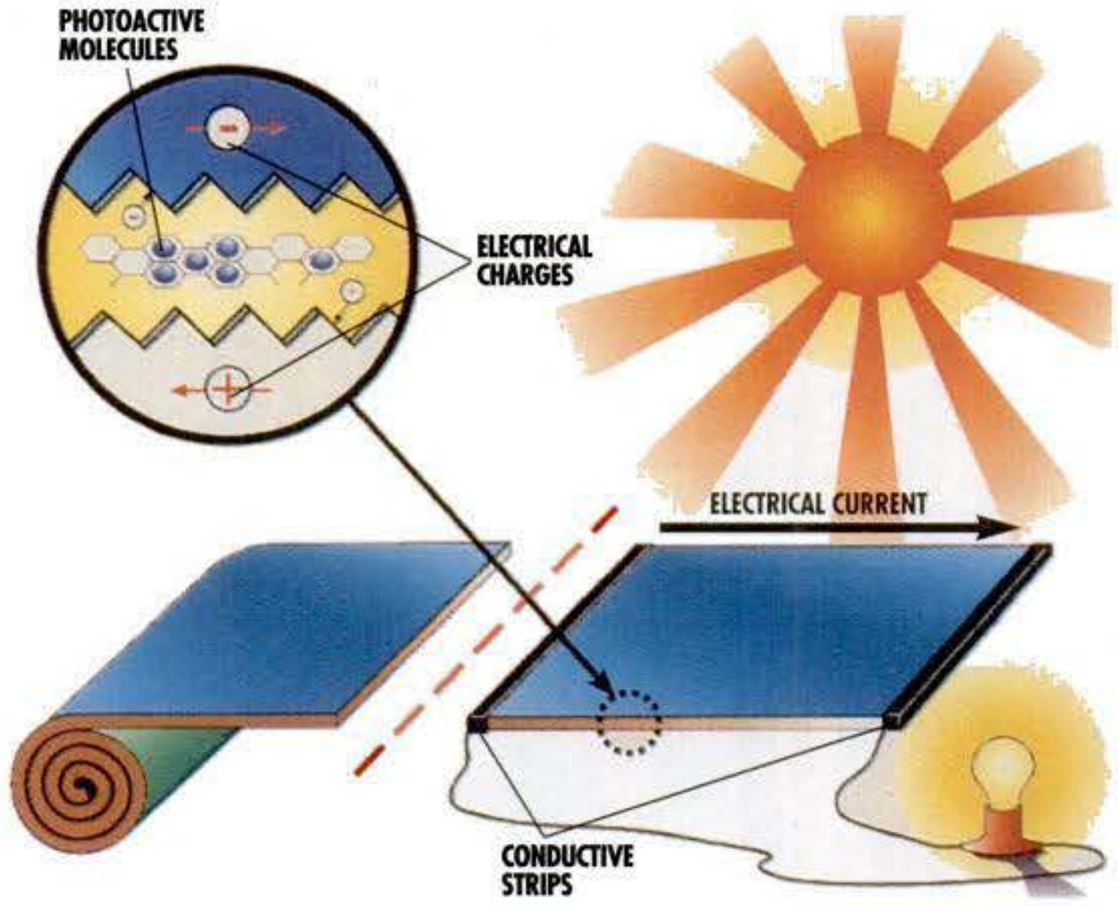
The remote control could be designed as a panic button on an officer's belt. Alternatively, the gun could contain sensors that would confirm the owner's identity—such as fingerprint imaging built into the trigger, or devices that would recognize the owner by the size and mass of his or her hand.

Weiss says that such smart guns, if successfully developed, would eventually find their way into private homes, where they could help prevent accidental shootings.

—Ray Nelson



This prototype revolver could be disabled by remote control.



When sunlight strikes photoactive molecules embedded in this conductive-polymer film, positive and negative charges separate and flow in opposite directions. Strips on the ends of the film draw off power.

ALTERNATIVE ENERGY

SOLAR ROLL

Imagine a flexible solar-cell film that could be stretched over a window awning or wrapped around any surface exposed to the sun. "You could roll down your awning in the sunshine and get power from it," says chemist Michael R. Wasielewski of Argonne National Laboratory.

Argonne and Advanced Research Development Inc. (ARDI) of Athol, Mass., have embarked on a three-year, $1.8 million project to produce such a film. They call it a "solar cell on a roll," because it would be manufactured in large sheets about the thickness of heavy-duty food wrap.

To make the solar cell, photoactive dye molecules developed at Argonne would be embedded in stretchable conductive films developed at ARDI. In a process somewhat akin to photosynthesis, sunlight excites the dye molecules, causing positive and negative electrical charges to separate. "The conductive polymer accepts the charges," explains Wasielewski. Positive and negative charges flow in opposite directions, creating a current across the polymer film. The researchers are studying ways to attach metal electrodes to the polymers to draw off power.

The Argonne-ARDI team aims to produce its solar cells, which have a theoretical efficiency of nearly 70 percent, for one-tenth the cost of silicon-based cells. "One of our goals is to make these things so cheap that they would be almost disposable," says Wasielewski. "This material could even be incorporated into packaging for other products."

AGRICULTURE

SOIL SAVER

Plastic mulch—nonbiodegradable, non-recyclable, and a thief of precious topsoil—may soon be obsolete. When field trials of an organic mulch made of jute fibers are completed this spring, farmers raising high-value crops such as strawberries, tomatoes, and melons will have the option of switching to a mulch that not only doesn't have to be removed from the fields but also improves the soil by adding humus as it biodegrades.

The idea began with Bill Jennings, a Santa Barbara, Calif., entrepreneur. Five years ago, he set out to design an inexpensive car that developing countries could manufacture from their own natural resources. He discovered that jute could not only be used to fabricate car bodies but could also be used in agriculture and erosion control. In 1993, he formed Olympia Natural Fibers to develop a process for turning jute into mulch.

After jute is harvested, the fibers are separated from the stalk, combed, and put through a web-forming machine that assembles the fibers into a mat. The mats are compressed by rollers and tangled on a needle board to weave the fibers. A layer of waxed Kraft paper is then glued to the mat, and the mat is coated with a plant-based wax or starch.

The purpose of the field trial—which encompasses approximately 100 acres in central California—is to test mats of various thicknesses, densities, and coatings to find the combination most effective in retaining chemicals that are injected into the ground to kill nematodes, fungus, and mold.

Besides adding humus to the soil, the biggest advantage of natural fiber mulch is that it doesn't have to be removed from the fields after the planting season.

"In California alone, there are 100,000 acres a year planted in high-value crops," says Jennings. "That's 100,000 acres of black plastic sitting in landfills that will never biodegrade. Imagine the possibilities worldwide."

—Karen Taylor Perger PS

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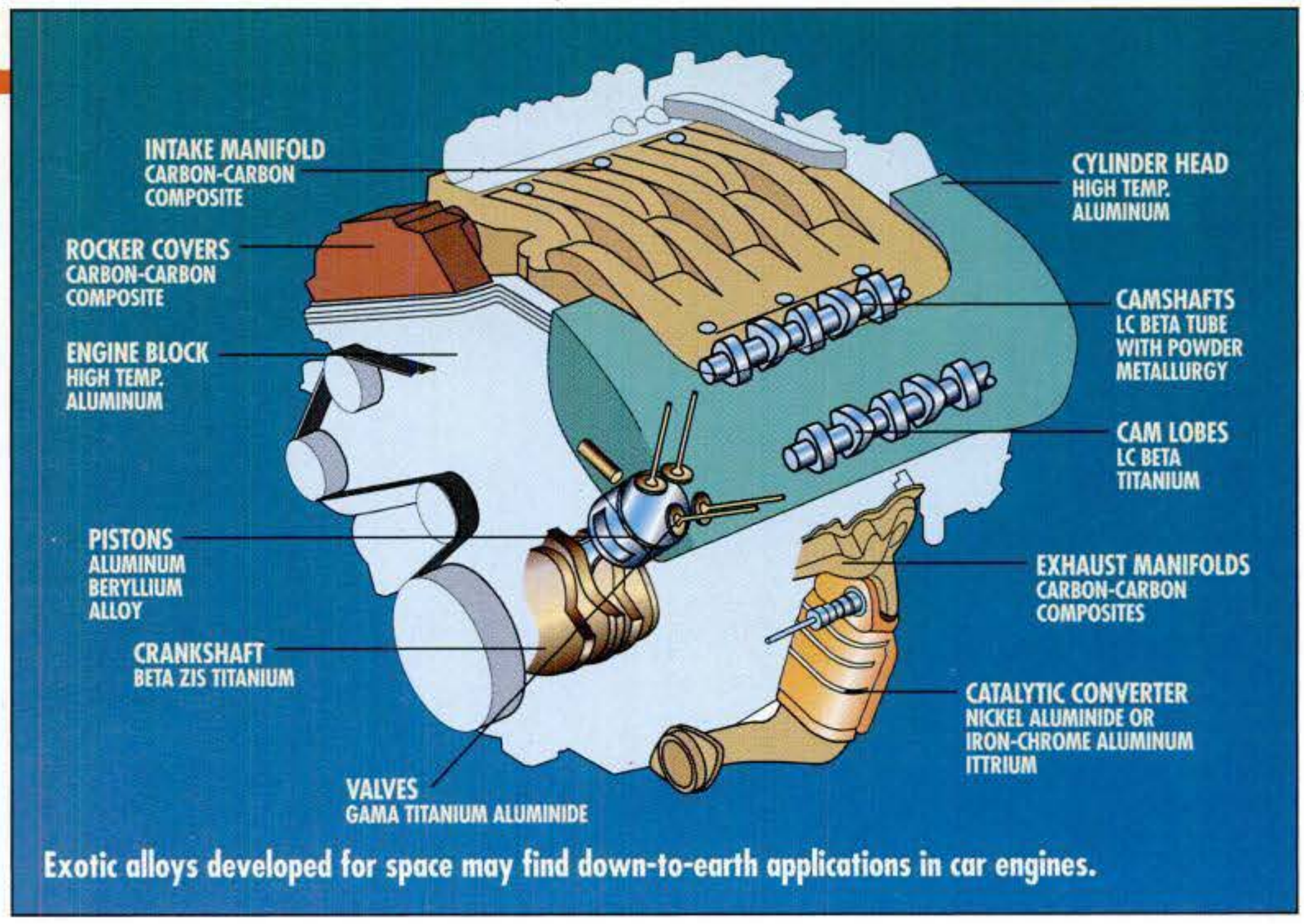

Exotic alloys developed for space may find down-to-earth applications in car engines.

MATERIALS

SPIRIT OF THE SPACE PLANE

The National Aerospace Plane (NASP)—a hypersonic vehicle that would whisk passengers into orbit en route to distant cities on Earth—is dead. But the exotic alloys developed for it are still alive and may find their way into future car engines.

A host of superstrong, superlightweight materials that were developed for the NASP would make ideal engine components, says Richard Delagi, with Texas Instruments' metallurgical materials division in Attleboro, Mass. The benefits? Enhanced performance and improved fuel mileage.

"Our projections suggest that an engine produced from NASP-derived materials would weigh 50 percent less than an identical engine made from conventional materials," says Delagi. It would have 50 percent less rotation and reciprocating mass and would be at least 20 percent more efficient than ordinary internal-combustion engines, he says. Reduced reciprocating and rotating weight would allow the energy produced from the combustion process to be used more efficiently.

The first phase of the program, overseen by TI's metallurgical division, calls for material analysis, followed by engine design and computer modeling work to be done by Callaway Advanced Technology in Old Lyme, Conn. During phase two, Callaway will construct a small engine that uses titanium alloys. The construction process should take between 18 and 24 months.

Titanium sponge, the raw material for making titanium and titanium alloys, varies widely in price, depending on its purity. Delagi says TI is experimenting with cheaper, less-pure raw material to keep the cost of components down. "In traditional aerospace applications, very high-purity sponge is used," he says. "If you can use less-pure sponge, you can drop the cost of the finished product."

TI has no delusions of instant acceptance of its radical materials by mainstream car manufacturers. Assuming the parts work well in their new environment, the alloys would first appear as aftermarket performance parts and in race car engines.

PREVIEW DRIVE

TERCEL: MISTAKEN IDENTITY?

From a long, long way off, one might mistake the 1995 Tercel for a BMW 3 Series. At least that's what Toyota engineers must have been thinking when they grafted sportier styling—including a BMW-like black door-guard strip and a fake air spoiler—to the fifth generation of Toyota's popular econobox.

More significant changes, though, appear under the hood. Toyota replaced the Tercel's 12-valve, 1.5-liter powerplant with the 16-valve, 1.5-liter engine borrowed from the Paseo. It also added an optional four-speed automatic transmission. The result: competent acceleration. On a test drive along California's coast, the Tercel did a good job of pulling its way up steep hills. Fuel efficiency also improves with the new model, to 28 mpg city/38 mpg highway for the automatic and 31/42 for the five-speed manual.

Interior changes focus on practical elements: Dual air bags are now standard, and the center instrument panel has been canted a bit closer to the driver. As in earlier versions, the new Tercel doesn't waste a cubic inch of possible leg- or headroom. That's good, because the car has slightly less interior volume due to the added bulk necessary to meet 1997 side-impact regulations. Still, four five-foot ten-inch adults can squeeze into the subcompact without painful contortions. Prices should run around $10,000 for the base model and about $13,000 fully loaded.—*Robert Langreth*

HIGHWAYS

POTHOLE PRODUCERS

According to highway engineers at the University of Michigan, a single 18-wheeled tractor trailer, which can weigh up to 80,000 pounds, inflicts as much damage on a road surface as 10,000 to 20,000 four-wheeled passenger cars. But as destructive as the big rigs are, they play a minor role in the degradation of America's infrastructure. Environmental factors and poor road materials do the most damage.

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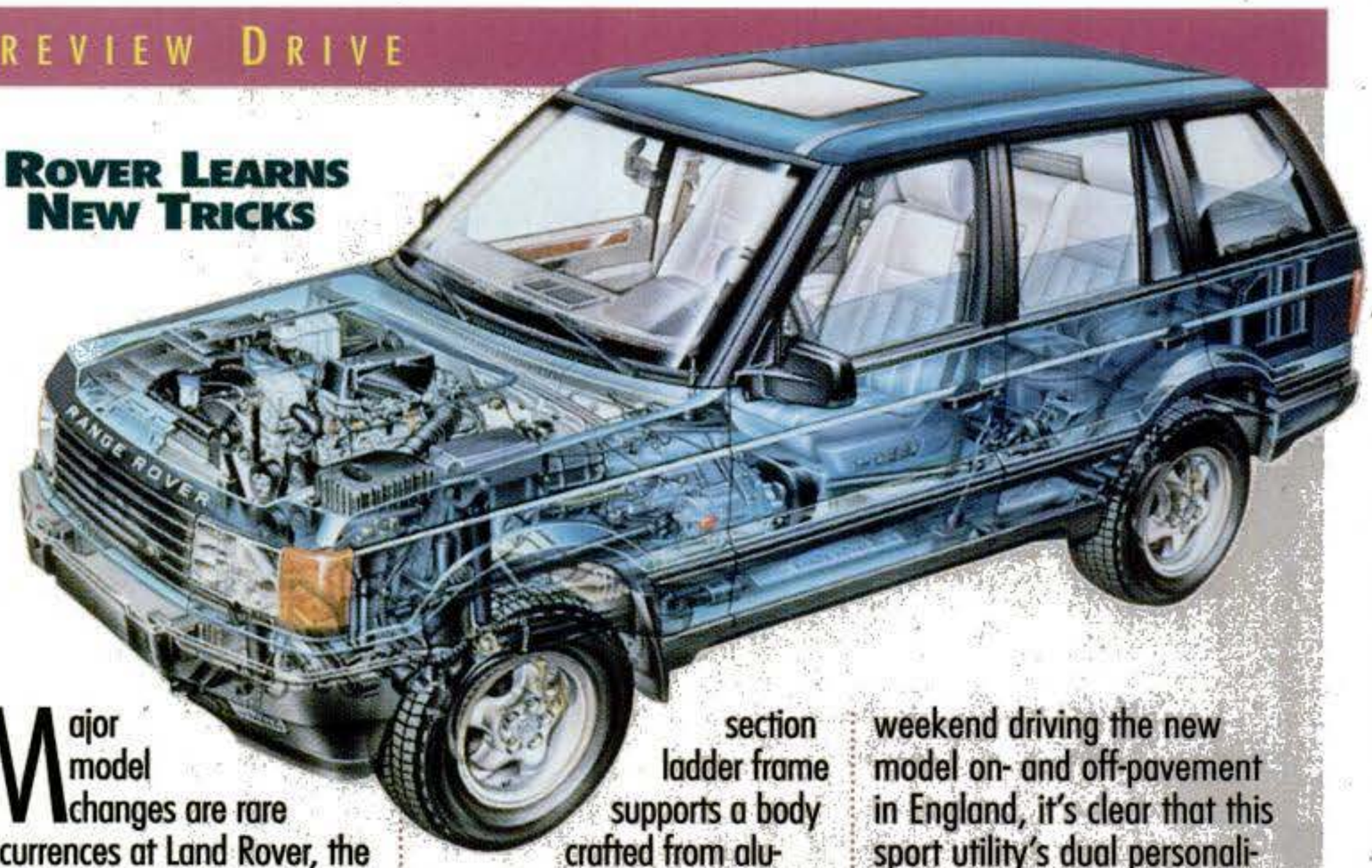
PREVIEW DRIVE

ROVER LEARNS NEW TRICKS



Major model changes are rare occurrences at Land Rover, the British purveyor of 4x4 trucks engineered for desert expeditions, jungle safaris, and queens' teas. The Brits have not changed their Range Rover model since its introduction in 1970, but a notable changing of the guard is in the offing: a 1995 Range Rover that shares only 1 percent of its components with its predecessor.

Alterations in outward appearance are evolutionary. As before, the stance is Big Ben upright, hood corners squared. But the new Range Rover model does concede to a slight stretching of exterior dimensions—more than three inches in width, and one-and-a-half inches in length. Body fit is also better. Harrod's couldn't have gift wrapped it any better.

The new Range Rover's box-section ladder frame supports a body crafted from aluminum and galvanized-steel panels. Variable-rate air springs positioned between rigid axles and the frame provide self-leveling and five driver-selectable ride heights. Antilock brakes and rear-wheel traction control are both standard equipment.

The most interesting innovation is a pair of fiberglass-reinforced-plastic trailing beams used to locate the rear axle, improving suspension geometry and the vehicle's dynamic response. This new rear suspension is aimed at eliminating the previous model's tendency to wag its tail during aggressive highway-speed maneuvers. Range Rovers have long been the king of off-road tractability but they lacked the poise for comfortable long-distance travel on the road. After a weekend driving the new model on- and off-pavement in England, it's clear that this sport utility's dual personalities are finally in synch.

Rover's all-aluminum V8 engine (which originally powered the 1961 Buick Special) displaces 4.0 liters and delivers 190 horsepower. A ZF four-speed automatic transmission and a Borg-Warner transfer case are both controlled by one handy H-gate shifter.

The new Rover's interior is roomier and more sensibly arranged. Dual air bags are standard and the back seat is a handy split-fold design that hinges out of the way. The spare tire stows flat in the bottom of the cargo compartment, and the tailgate folds down to provide table service for canapes at the polo match. Life in the Range Rover lane is very comfortable indeed.—*Don Sherman*

FLYWHEELS

SPIN MASTER

Demonstrating spinning action that would put the infamous Tasmanian Devil cartoon character to shame, a flywheel system from SatCon Technology Corp. recently ran circles around a nine-year-old speed record for flywheels.

SatCon, based in Cambridge, Mass., is developing a flywheel that will store energy for Chrysler's Patriot race car, part of an R&D effort that will test several innovative technologies on the race track ["Emerging Technologies for the Supercar," June, '94].

In automotive applications, flywheels store electromechanical energy by spinning rapidly on near-frictionless bearings. A motor/generator can either charge the flywheel so that it spins faster to store more energy, or draw on the stored energy of the flywheel to help power the vehicle. Flywheels could also collect energy from braking to pump up their rpm.

In tests conducted at Barbour Stockwell Co. in Cambridge, the rim speed of SatCon's two-foot-diameter flywheel reached 4,668 mph. The old record, 3,100 mph, was set in 1985 at Oak Ridge National Laboratory in Tennessee.

Specifications for the Patriot call for a flywheel that spins at around 1,000 mph, says Michael Turmelle of SatCon. "We have a safety margin of four," he says. "That's very comfortable."—*Mariette DiChristina*

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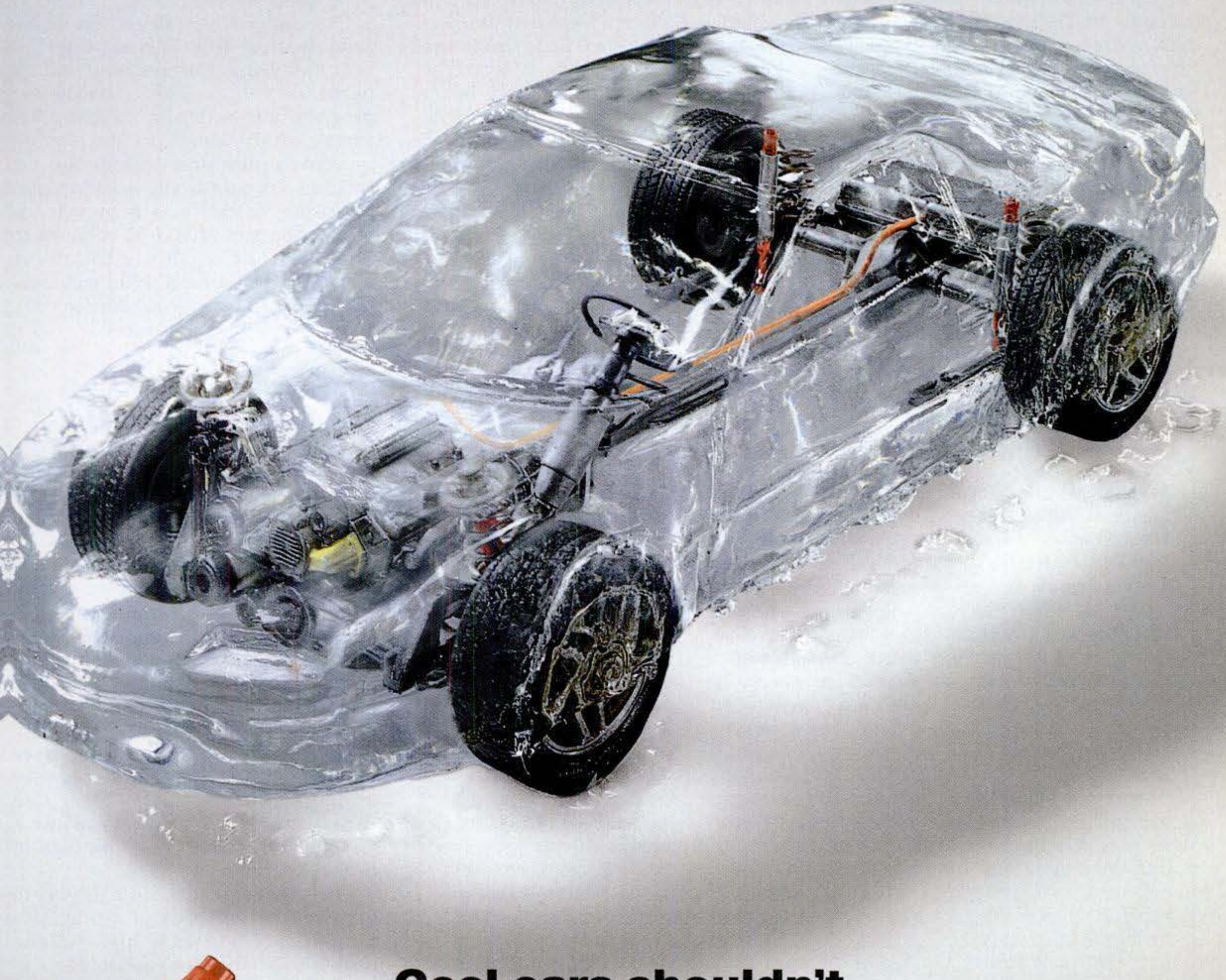

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ELECTRIC CARS

SUNRISE FOR SOLECTRIA

Unveiled this month: an all-new electric car from Solectria.

This month, the Solectria Corp., Wilmington, Mass., unveils its new electric car, the Sunrise. The prototype represents a departure for Solectria, which has been selling converted Geo Metros and Chevy S-10 pickups as electric vehicles. The Sunrise, by contrast, is designed from the ground up as an electric vehicle. "This is not a flashy showcase car," explains Solectria vice president Arvind Rajan. "The whole point is to develop a practical and economical production vehicle."

Sunrise is a four-passenger, two-door car weighing less than 1,000 pounds (without batteries) and offering power steering, power brakes, air conditioning, air bags, and the trunk space of a conventional mid-size car. Maximum speed is 70 mph, say Solectria engineers, and the car should reach 60 mph in about 14 seconds.

Though the dashboard, front seats, and composite chassis will be custom-designed, Solectria borrowed the electrical and drive systems from the Force, its converted Geo Metro. The brakes, steering system, and lights will come from traditional auto suppliers. "Given our limited resources," says Rajan, "we cannot afford to reinvent the wheel."

With 800 pounds of lead-acid batteries, the Sunrise should travel about 100 miles before needing a recharge, although nickel-metal hydride or nickel-cadmium batteries could be used to double the car's range. The battery pack will be laid out along the center tunnel to optimize safety and handling.

The Sunrise will begin extensive road testing this spring. For the next two years, the company and its partners will pursue a crash-test program and a design-for-manufacturing study aimed at developing new materials and techniques for turning out cars at the lowest possible price. Solectria is hoping for a production run of 10,000 vehicles to keep the price down to about $17,000 for the car's 1998 commercial introduction.—*Steve Nadis*

PREVIEW DRIVE

CAT REDUX

It's almost obligatory to watch the demonstration of craftsmen placing wood inlay on the glove box door at the Jaguar Cars plant in Coventry, England. Less romantic, but more indicative of what Jaguar is doing today, is the assembly-line worker threading a new, state-of-the-art wiring harness through channels stamped in the floor pan of the new XJ-6 sedan.

The wiring harness, developed by United Technologies at the behest of Ford engineers, is a response to Jaguar's legendary history of electrical problems. Ford's purchase of Jaguar has been having a positive impact. In fact, a new stamping process developed by Ford enabled Jaguar to return to the flowing, convoluted hood that distinguished the old XJ-6. The new hood is an efficient two-piece assembly that retains the traditional XJ-6 contours.

The new XJ-6 is full of similar innovations aimed at enhancing reliability and improving power and handling. The new XJR 4.0 six-cylinder, for example, is the first supercharged engine in Jaguar's history. Its Eaton supercharger, tucked neatly alongside the block and feeding through a water-cooled intercooler, boosts output to 328 horsepower with 378 foot-pounds of torque—numbers that approach the Dodge Viper class of power. The engine has little problem moving the 4,134-pound XJ-6 at something more than sedate speeds.

Steering response is excellent—much improved from previous generations. Another welcome addition is the installation of air bags; Jaguar now has them on both sides, a concession to modern safety necessities, along with an antilock braking system and traction control.

This new Jaguar is more than an acknowledgement of tradition. The Ford/Jaguar liaison has produced a modern, stronger and faster luxury car that embraces its past with its styling and sense of dignity. The guy installing the wood inlay would be proud.
—*Dan McCosh*

RESEARCH

NEON LIGHTENS UP

Don't expect an all-aluminum car anytime soon from Chrysler, despite the recent unveiling of a Neon "Lite."

The Neon Lite uses body panels, deck lid, hood, doors, and an engine block made of aluminum, along with a magnesium instrument panel, composite bumpers, and a titanium exhaust system. This shaves roughly 600 pounds off the car's already modest 2,625-pound curb weight.

The weight reduction improves handling and steering and enhances engine performance. The Neon Lite runs zero-to-60-mph times roughly a second faster than the production car's 8.8 seconds.

Chrysler engineers built the car to explore the logistics of using aluminum in traditional high-volume unibody production methods. Extruded aluminum space frames used by Audi, Chrysler engineers argue, are better suited to high-priced, low-volume cars.

The big challenge was connecting aluminum pieces together. Compared to welding steel, extremely high energy is required to spot-weld aluminum, necessitating a new approach. Researchers hit on a combination of rivets and adhesives to equal the strength of welding. Some components from the program will make it to the production Neon.
—*Jon Lowell*

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POLLUTION

THE COST OF CLEAN AIR

BY WADE HOYT

A little-known provision in the Amendments to the 1990 Clean Air Act may hit you where it hurts most—in the pocket. It requires that the EPA implement tougher automobile smog checks in areas that don't meet federal air quality standards. These emission inspections affect 83 urban areas and their surrounding suburbs (see map), home to an estimated 56 million cars and light trucks. If your vehicle doesn't pass muster, you'll have to pay for repairs.

If you live in one of these areas and own a car or truck, your vehicle will be subjected to a four-minute "drive" on a dynamometer at speeds up to 55 mph while exhaust gases are analyzed. This is a much tougher exam than the more common emissions test done with the engine idling. The EPA calls the 240-second test I/M 240 (I/M for inspection and maintenance). Two additional tests of the fuel and evaporative systems are also mandatory.

The EPA estimates that up to 30 percent of the cars tested will fail at least one of the three tests. To help ease the pain, the EPA has capped repair costs at $450; if a car still won't pass after a $450 repair bill, the owner will be issued a waiver that exempts the car from further tests for two years (when the next test is required) or until the car is sold, whichever comes first. The dollar amount of the waiver will be adjusted upward for inflation.

To avoid the conflict of interest that could arise when the same repair shop that administers the test also does the repairs, the EPA is establishing separate, test-only inspection centers. The test fees will run $14 to $25. So far, only affected sites in California, Georgia, and New Jersey have been allowed to set up programs in which newer cars can be tested and serviced at the same site. Older vehicles must go to a test-only center.

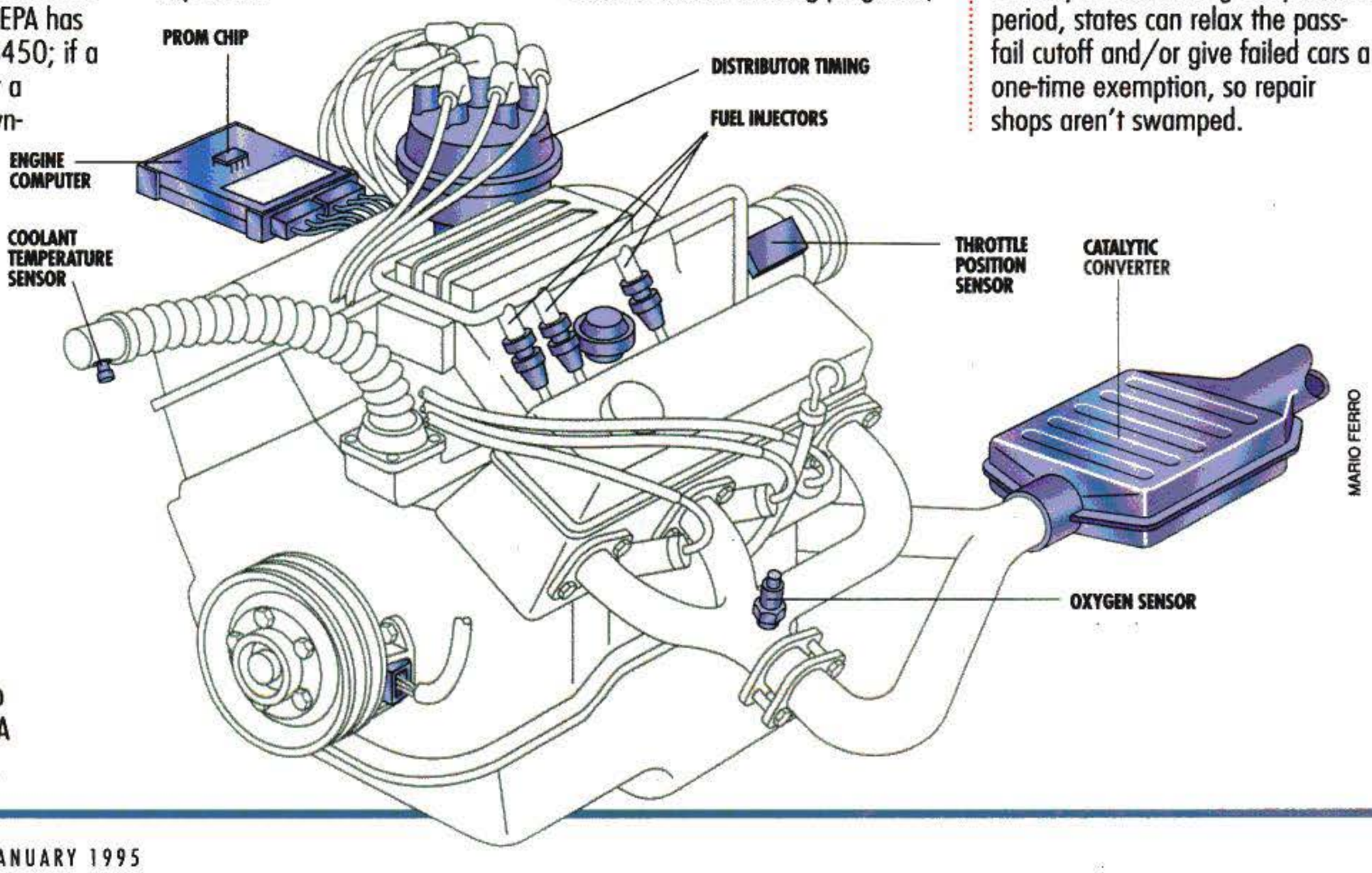
The EPA claims that the average repair bill after failing I/M 240 will be between $120 and $150, and that repairs to the evaporative emission system will cost $38 to $70. The EPA also predicts that improvements in fuel economy that will arise from the repairs will help offset the cost of the work. Cars brought up to par with I/M 240 standards, it says, will get an estimated 12.6 percent better fuel economy. Evaporative emissions repairs should boost mpg by about 6 percent.

Shaded areas indicate where new, tougher I/M 240 tests will be phased into law during 1995. The parts most likely to need repair or replacement are detailed below. Vacuum leaks and the EGR system, not shown in this drawing, may also need attention.

Preliminary I/M 240 tests run in Phoenix found that failed vehicles needed the following repairs: replace oxygen sensor, 67 percent; replace catalytic converter, 29 percent; repair ERG system, 29 percent; fix vacuum leaks, 16 percent; clean or replace fuel injectors, 13 percent; adjust timing, 10 percent; adjust fuel system, 10 percent; replace throttle position sensor, 6 percent; replace coolant temperature sensor, 6 percent; replace PROM chip, 3 percent; replace engine control computer, 3 percent (see diagram).

States with areas that do not meet federal air quality standards must establish training programs, newsletters, and telephone hot lines to help technicians make the fixes necessary to pass the tests. To further complicate matters, local repair shops need expensive dynamometer installations to duplicate the I/M 240 test, a luxury few of them can afford. This will leave many mechanics shooting in the dark with their fixes. States will therefore issue reports showing individual shops' I/M 240 pass/fail records on repair jobs to help consumers find shops with the know-how to do the job correctly.

I/M 240 programs will be phased into operation during 1995 and must be fully operational by January 1996. During the phase-in period, states can relax the pass-fail cutoff and/or give failed cars a one-time exemption, so repair shops aren't swamped.



SEBRING/AVENGER: FAMILY VALUE

The new Dodge Avenger and Chrysler Sebring that will appear this February are two-door cousins to Chrysler's new Cirrus and Stratus compact sedans. Sebring and Avenger are larger than most competitive front-drive sport coupes, but their 103.7-inch wheelbase is about five inches shorter than the wheelbase of their four-door siblings.

The result is a pair of technically sophisticated coupes reflecting the tastes of Baby Boomer auto enthusiasts who want a bit more room in their waistbands and in their sporty cars. Declining sales in sport coupes have been blamed partly on the aging population of car buyers. The Avenger and Sebring address this by emphasizing style and luxury rather than performance and handling.

The suspension is full wishbone front and rear, adapted from the Cirrus/Stratus duo, as is the power-assisted rack-and-pinion steering. Engines available include a 132-hp, 2.0-liter, 16-valve DOHC four-cylinder (shared with the Neon), and a Mitsubishi-based 155-hp, 24-valve SOHC cast iron V6—which uses Chrysler's latest-generation engine control system. Curb weight for the Avenger/Sebring is 2,888 pounds—nearly 300 pounds less than their four-door cousins.

This trimmed-down package should be capable of superior performance, compared to the Cirrus and the Stratus, without relinquishing too much front-seat room.

Chrysler already has offered the new body style to the stock car racing circuit, and the Avenger is in the unusual position of having a full season of racing under its belt before it goes on sale. But there is little mechanical similarity between the race cars and the production versions.—*J. L.*

The Avenger/Sebring is lighter and sportier than the new Cirrus/Stratus sedan.

Top of the food chain: The Mercedes-Benz S Class (left) and the BMW 740i are nearly perfect driving machines.

SUBTLE LUXURY

At the upper echelons of the European luxury car segment, there's not much room for rising prices. Judging from the newest incarnations of the BMW 740i and the S320 Mercedes, there's not much room left for further refinement, either.

The two prestige sedans from these German car makers have several things in common. Both have uncommonly stiff chassis that contribute to substantial curb weight. Both engines are complex, small-displacement motors that produce large amounts of horsepower and torque for their size, but are still considered mid-range by U.S. standards. Then there's the sense of mechanical harmony—the way both cars' systems and structures flow together and work as a whole.

The new BMW 740i is an uncannily smooth car with impeccable road manners. Rock-solid and roomy by European standards, it combines genuine high performance with luxury. Its appearance is similar to that of its predecessor, but it sure feels different. The chassis is even stiffer, and the seats are even more supportive and comfortable than the ones they replace. Steering response has also been improved. And there are more interior electronics, including controls to operate the compact disc player that are fitted into the steering wheel. BMW spent more than $1 billion on improvements that some may deem subtle. Still, the changes move the 740i one step closer to earning the title "the ultimate driving machine."

But the new S class from Mercedes Benz could be the line that contests that august distinction. Exterior styling details have been changed, and the interior finally sports cup holders. All of the new S-class cars are still extremely strong and use stiff chassis, exuding a sense of precision. Unfortunately, the fee for this feel is a hefty, 4,610-pound curb weight. The 123.6-inch wheelbase and the 205.2-inch overall length make this car large even by American standards and allow for a roomy back seat. Mercedes has cut the price of the S320 by some $4,700, but it still costs about $70,000—without options.

The 320 in-line six produces 228 hp with 232 foot-pounds of torque. That provides solid acceleration, while the suspension easily handles the big car's weight on sweeping highway corners. Electronic traction control now is standard.

With both of these German luxury cars near the end of their development cycle, they are likely to remain icons of near perfection for the foreseeable future, unless the growing interest in lighter weight and improved efficiency disturbs their position in the automotive spectrum.
—*D. M.* PS

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Bad to the

Say goodbye to the mild-mannered, switch-on-the-cruise-control and are-we-there-yet? four-door sedan. With a Corvette-derived, 260-horsepower LT1 engine and a suspension package originally designed to support your local sheriff, the 1995 Chevy Impala SS doesn't take a back seat to anyone (although, speaking of back seats, this one's real comfy). Up front

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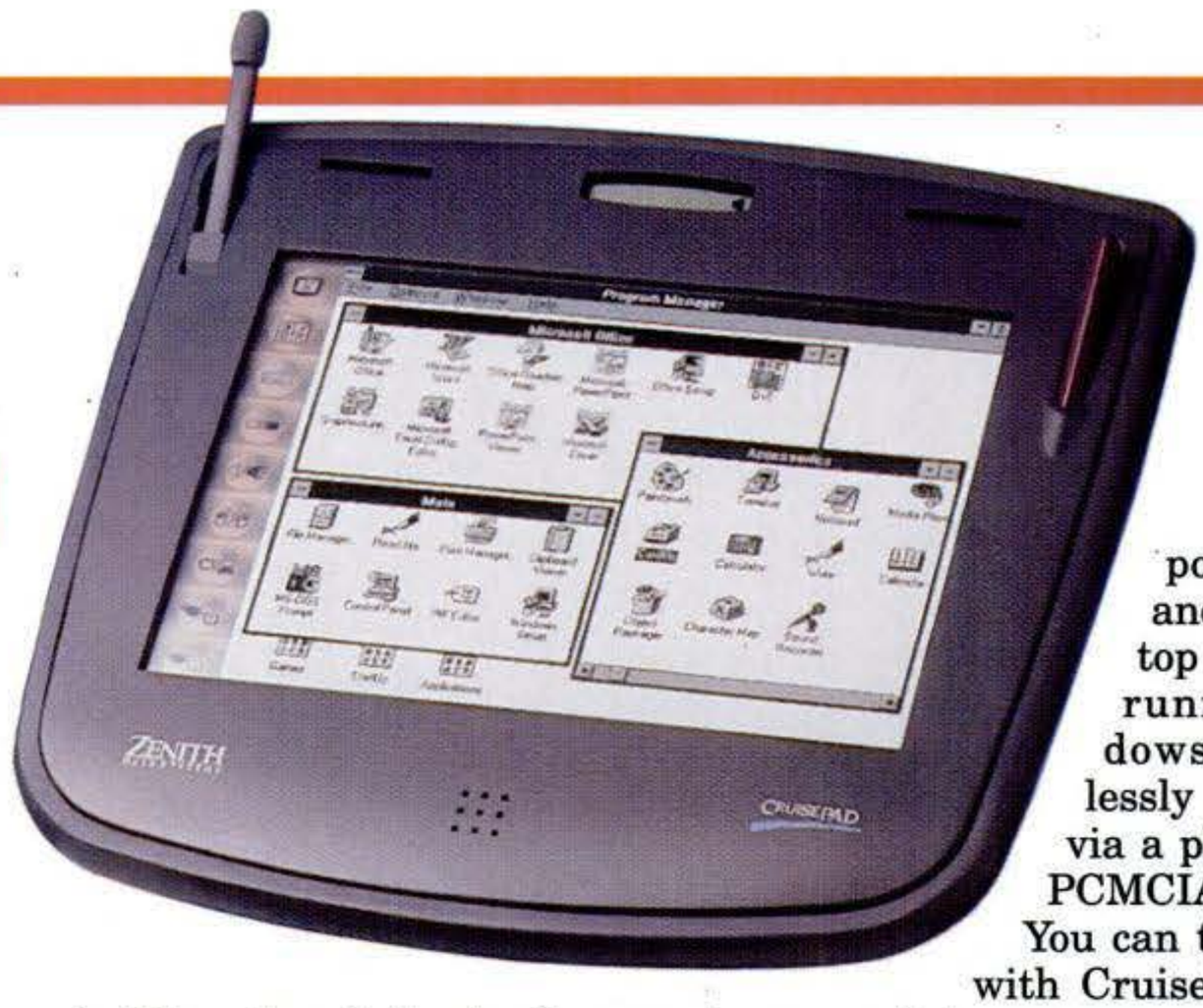

Via a radio link, CruisePad enables you to control what's happening on your desktop PC from up to 500 feet away.

REMOTE CONTROL

CORRIDOR CRUISING

If advertisements are to be believed, then the typical portable-computer user is a jet-setting executive with a taste for pie charts. But Zenith Data Systems is challenging that stereotype with a new product aimed at "corridor cruisers," individuals who do most of their traveling within a single building or campus.

Called CruisePad, the new device enables you to see and control what's happening on your desktop or laptop PC while you move within a fixed area—whether it's a house, office building, hospital, school, or construction site. Weighing in at about three pounds, CruisePad is lighter than most notebook computers and slightly smaller. But CruisePad isn't really a computer; it's more like a remote control with a big screen.

CruisePad is essentially a thick LCD panel with a radio-based transmitter and receiver inside. (The display is in black and white for now; the company plans to offer a color version soon.) It has no hard disk drive, no floppy drive, and little memory. Instead, it taps the processing power, storage space, and memory of a desktop or laptop PC that's running DOS or Windows. The PC is wirelessly linked to CruisePad via a plug-in radio board or PCMCIA card (for laptops). You can then control your PC with CruisePad from up to 500 feet away.

CruisePad lets you do almost anything you can do when you're sitting in front of your desktop, including running applications and connecting with other systems or on-line services (to check your e-mail, for example). You maneuver around the screen using a touch-pen, or stylus. There's an on-screen keyboard for typing; you can add a conventional keyboard as well. CruisePad lists for $1,399. The plug-in board and PCMCIA card sell for $595 and $695 respectively.—*Chuck Murray*

OPERATING SYSTEMS

THE RETURN OF OS/2

Windows users may be waiting longer than expected for the next version of the mega-popular operating system, but OS/2 devotees are setting their engines to warp speed now. The latest version of IBM's 32-bit operating system, called OS/2 Warp V3, is leaner and sweeter than earlier releases—and has several features the forthcoming Windows 95 won't have.

OS/2 Warp actually comes in two versions: a "full pack" edition that can run OS/2, DOS, and current Windows programs directly, and a Windows edition for people who already have DOS and Windows on their PCs. Each is expected to sell for less than $100. Better still, both versions come with a bundle of OS/2 applications, including a new collection called IBM Works. Both versions will also run comfortably on a PC with four megabytes of memory. Previously, OS/2 required 8MB or more.

Installing OS/2 Warp is far simpler than before, and its new interface sports colorful 3-D icons and a "launchpad" for starting programs quickly. Warp makes it easier to tap into the Internet too, by providing software that gives you one-button access to the IBM Global Network. One possible drawback: OS/2 Warp may run some, but not all, of the programs written for Windows 95, which is due to be released by summer.

OS/2 Warp V3, the newest version of IBM's operating system, installs easily, runs on PCs with four megabytes of memory, and comes with a bundle of applications.

ON-LINE

SHOPPING THE INTERNET

Convenient access to a variety of goods and services is one of the Internet's more enticing promises. And it looks like the promise will become reality this year.

Home Shopping Network (HSN), the company that helped popularize shopping via TV, is bringing its expertise to the Internet. HSN recently purchased Internet Shopping Network, which has sold software over the Internet for two years. HSN plans to offer other products, from TVs and VCRs to T-shirts and tennis shoes.

Buying and selling on-line is hardly new. Services such as America On-line, CompuServe, and Prodigy have had such capabilities for years. But the wide-open nature of the Internet—in contrast to the controlled membership of commercial on-line services—makes it difficult to ensure that credit-card transactions are secure. A new company called CyberCash Inc. thinks it has a solution. Its encrypted information protocol will allow you to pay for Internet purchases in privacy with a credit card or an electronic bank transfer, according to the company.—*Suzanne Kantra*

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PATENTS

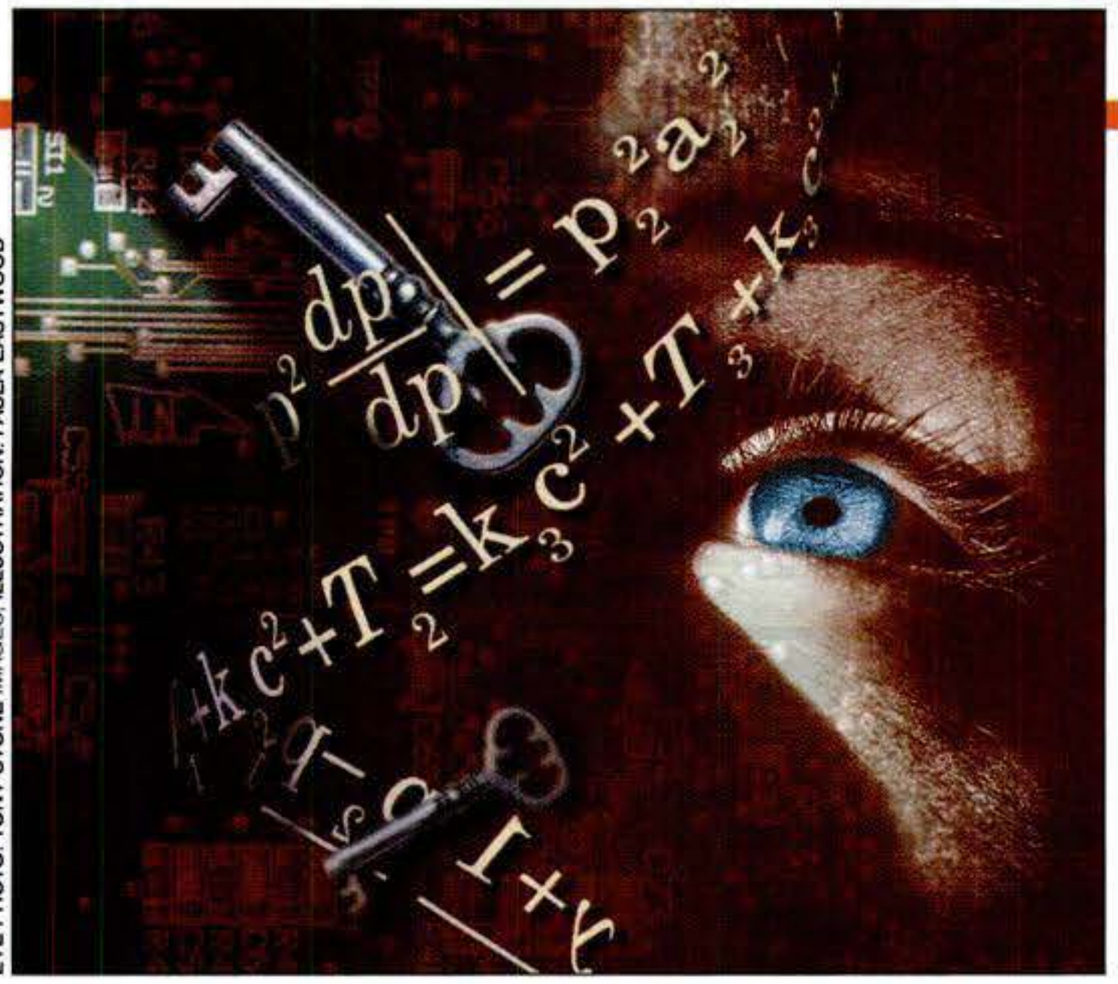
DIGITAL COPYRIGHTS

When should companies be permitted to patent software? That question is at the center of a controversy that could affect the type and diversity of software you see, and the price you pay for it.

A chorus of critics contend that the U.S. Patent and Trademark Office—in the absence of clear guidelines for granting software patents—is stifling innovation by bestowing overly broad patent awards to individual companies. As evidence, these critics cite a laundry list of seemingly dubious patents, including one that purports to cover how schoolchildren interact with a computerized video, and another award that protects the use of any advertising logo or character in software.

But the most contentious patent to date is one granted to Compton's New Media that covers most techniques for finding and retrieving information from a multimedia database. Patents like this, critics believe, could curb the rapidly expanding field of multimedia software and prevent smaller companies, which cannot afford the potential legal battles, from marketing new types of programs. The Patent Office has since overturned the Compton's patent, though its ruling is not yet final.

But the future may look brighter. The Patent Office last summer hired outside experts to examine software patent applications, and it began to work with an industry group called the Software Patent Institute. The government is also considering publicizing patent applications—which are now kept confidential—so that other companies have a chance to contest claims before they become legally binding.—*Robert Langreth*



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SECURITY

EYE PATROL

Those lovely lamps, those windows on the soul," waxed the French poet Guillaume de Salluste, Seigneur du Bartas, about the eyes more than 400 years ago. Interpreting him literally, Los Alamos National Laboratory researchers have developed a new identity-verification system, dubbed Bartas, that checks people's identities by studying their irises.

Biometrics—the science of verifying identities by biological characteristics—has become one of the hottest specialties in the security business. Devices that automatically recognize fingerprints and detailed hand shapes are in widespread use today. But iris patterns are actually more complicated than fingerprints and other external patterns and are thus more reliable, say the Los Alamos scientists, Roger Johnston and Kevin Grace.

To use Bartas, someone must first have his iris pattern scanned into a computer. When that person wants to enter a secure area, he leans over a see-through podium that holds a high-resolution video camera, which scans his iris and sends the image to the lab's Macintosh Quadra 650. The computer then compares the two iris patterns using mathematical algorithms.

Currently, the Los Alamos prototype has a 2 to 4 percent error rate—as good or better than most commercial biometric systems. The researchers believe they can slash the error rate even further, however, as most of the errors stem from people who fidget while being scanned. —*R. L.*

PERSONAL FINANCE

QUICKEN PLENTY

Millions of people use Intuit's Quicken to help keep their heads above water financially. The latest versions of the program add a host of new flotation devices.

The improvements in Quicken 8 for DOS, Quicken 4 for Windows, and Quicken 5 for Macintosh ($40 each) aim to make getting started easier for newcomers, while giving experienced users more insight into their finances. Among the highlights are a streamlined "interview" process for setting up accounts, a "snapshot" overview of your monetary standing, and better tax-planning tools.

A deluxe edition of Quicken for Windows, available on CD-ROM or floppy disks ($60), includes extras such as a home inventory manager and an on-line tax guidebook. The CD-ROM edition adds several multimedia features, including advice from financial experts.

COMMUNICATIONS

THE 28.8K CROWD MOVES IN

An international standard for modems that move data at 28,800 bits per second (bps) has finally been ratified, and modem makers are eagerly rushing new products to retail shelves.

The 28,800-bps standard, known as V.34, enables you to transmit data at twice the previous V.32 standard of 14,400 bps. Actually, modems running at 28,800 bps have been around for about a year, but these models used an interim standard called V.Fast or V.FC, and didn't always communicate easily with one another. The new V.34 standard should eliminate those problems. V.34 is compatible with all earlier standards, ranging from 300 bps to 28,800 bps.

AT&T, Hayes, and U.S. Robotics are among the companies expected to sell V.34 modems soon. Many V.FC modems—some touted as "V.34 Ready"—can be upgraded to the new standard with either a chip implant or a software update. Most on-line services don't yet support 28,800 bps but are expected to later this year. —*Candace Golanski*

U.S. Robotics' Courier modem incorporates a new standard for transmitting data at 28,800 bits per second.

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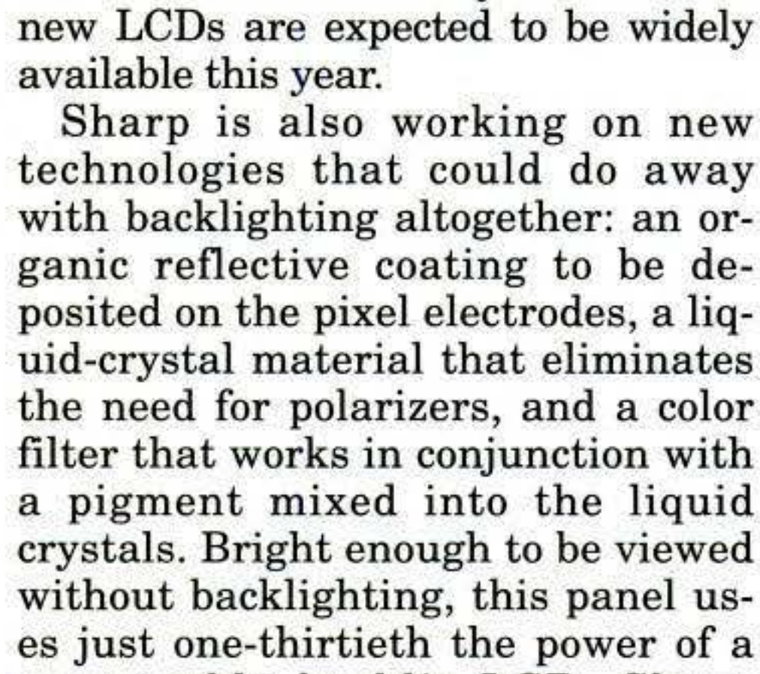
DISPLAYS

LOW-POWER LCDs

One of the biggest drains on portable computer batteries is the backlighting used to illuminate liquid-crystal displays. But an upcoming generation of LCD panels cuts backlighting levels while maintaining brightness, thereby lengthening the battery life of portable PCs.

Color LCDs typically have two or four fluorescent tubes built into their thin-screen panels. In front of these lights are polarizers, color filters, and thin-film transistor (TFT) circuits that cut the amount of light reaching the viewer's eye by 50 percent or more. But NEC, Fujitsu, and Sharp have each announced prototype LCDs with new color filters and polarizers, and smaller TFT elements, that allow more light to pass through. This allows LCD makers to achieve the same brightness levels using only one fluorescent tube.

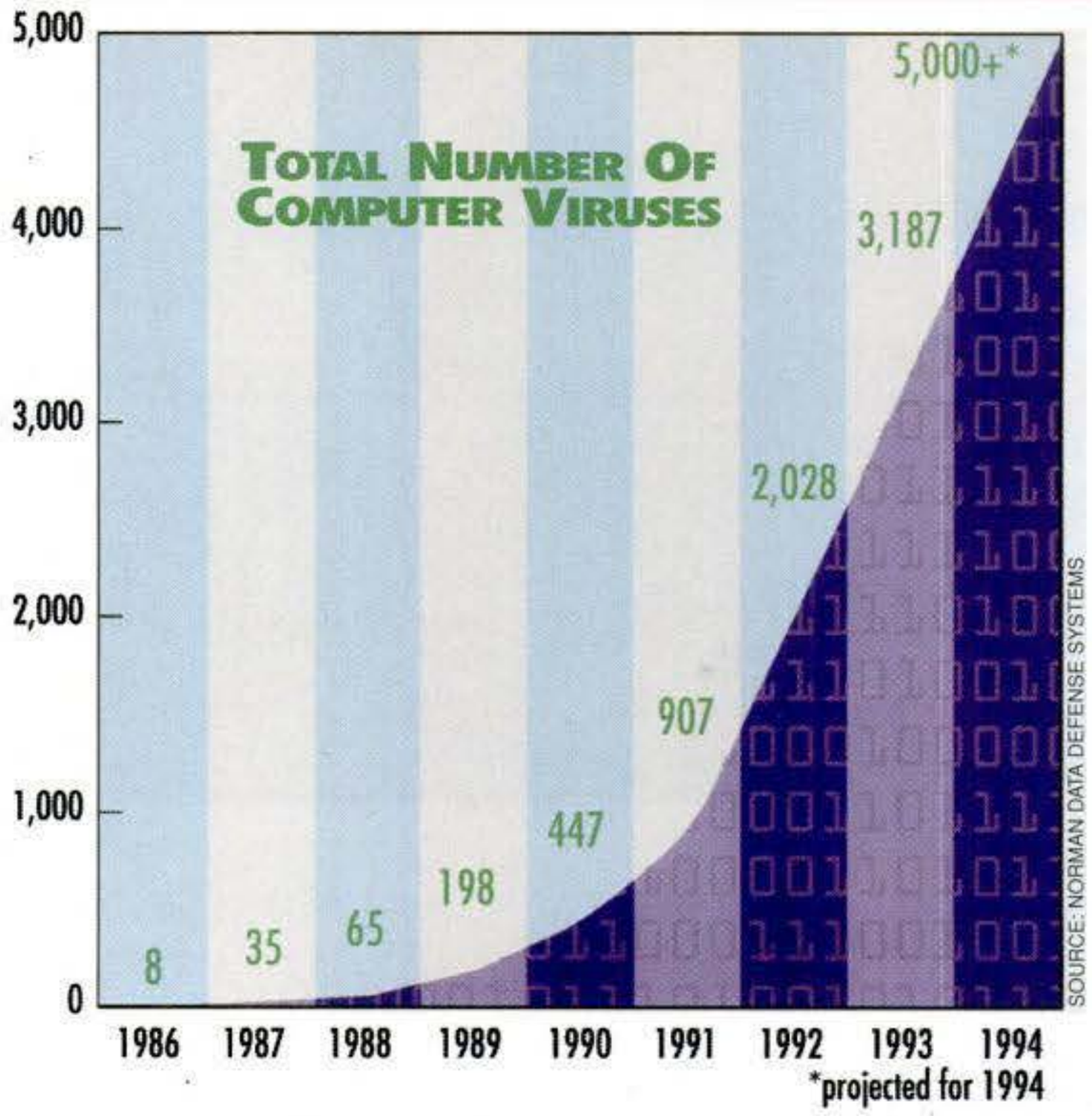
Sharp's latest 10.4-inch LCD panel, for example, uses just 2.9 watts of



A new generation of LCD panels will make laptop batteries last longer.

power, or about 20 percent less than its previous LCDs. The company figures this will extend the one-charge life of a color notebook by an hour. The new LCDs are expected to be widely available this year.

Sharp is also working on new technologies that could do away with backlighting altogether: an organic reflective coating to be deposited on the pixel electrodes, a liquid-crystal material that eliminates the need for polarizers, and a color filter that works in conjunction with a pigment mixed into the liquid crystals. Bright enough to be viewed without backlighting, this panel uses just one-thirtieth the power of a comparable backlit LCD, Sharp claims.—*Dennis Normile*



Within just eight years, the number of computer viruses worldwide has jumped from eight to more than 5,000.

VIRUSES

A QUIET THREAT GROWS

Early in 1992, doomsayers were predicting that the widely publicized Michelangelo virus would wipe out millions of PCs. Few PCs were infected, as it turned out, and the hype over computer viruses was soon replaced by complacency. But most experts agree that the number of computer viruses is still growing rapidly—and they're spreading all over the world.

"The problem is getting worse," insists David Stang, president of Norman Data Defense Systems, a computer security company in Fairfax, Va. "There's a tidal wave of viruses out there, and our sense of protection is slipping away."

While not all experts are that pessimistic, the numbers are not encouraging. More than 1,000 new viruses are being authored every year, according to Norman Data, which maintains a database of all the viruses it finds. From a mere eight strains in 1986, when they were first detected, the total number of computer viruses today may top 5,000, according to the company. Moreover, viruses are multiplying unchecked in some parts of the world, such as China. Journals and programs that teach people how to write viruses are spreading too.

How do you protect yourself? So-called "anti-virus" programs catch and neutralize hundreds of the most popular viruses, though some "stealth" strains can elude detection. The National Computer Security Association (NCSA) and 3M Corp. publish a brochure called "How To Avoid Computer Viruses," which is available for $2 by mail (Box 8031, Young-America, MN 55551) or through the CompuServe service (Go NCSA).

TOP TEN INTERNATIONAL COMPUTER VIRUSES

		Number of Countries Appeared
1.	Dark Avenger (all variants)	10
2.	Jerusalem (all variants)	10
3.	Joshi	10
4.	Brain	9
5.	Green Caterpillar Family	9
6.	Keypress (all variants)	9
7.	Michelangelo (all variants)	9
8.	Stoned B	9
9.	Vienna (all variants)	9
10.	Azusa	8

PORTABLES

PENTIUM TO GO

The Pentium chip is finally hitting the road. Intel's fifth version of its top-drawer microprocessor, and the first one designed for use in notebook computers, is set to spawn a slew of long-awaited Pentium-based portables.

The new Pentium processor runs at 75MHz—faster than the original 60MHz and 66MHz chips, but slower than the more recent 90MHz and 100MHz designs. These other four Pentium chips are used almost exclusively in desktop models, however. The 75MHz Pentium is a low-voltage chip with power-management features built in for longer battery life in portable PCs. It will compete principally with Intel's own 486-level DX4 chip, which also runs at 75MHz in most notebooks. The Pentium-75 runs nearly twice as fast as the DX4-75.

Most leading notebook makers, including Compaq and Toshiba, say they intend to use the Pentium-75 in upcoming models. PS

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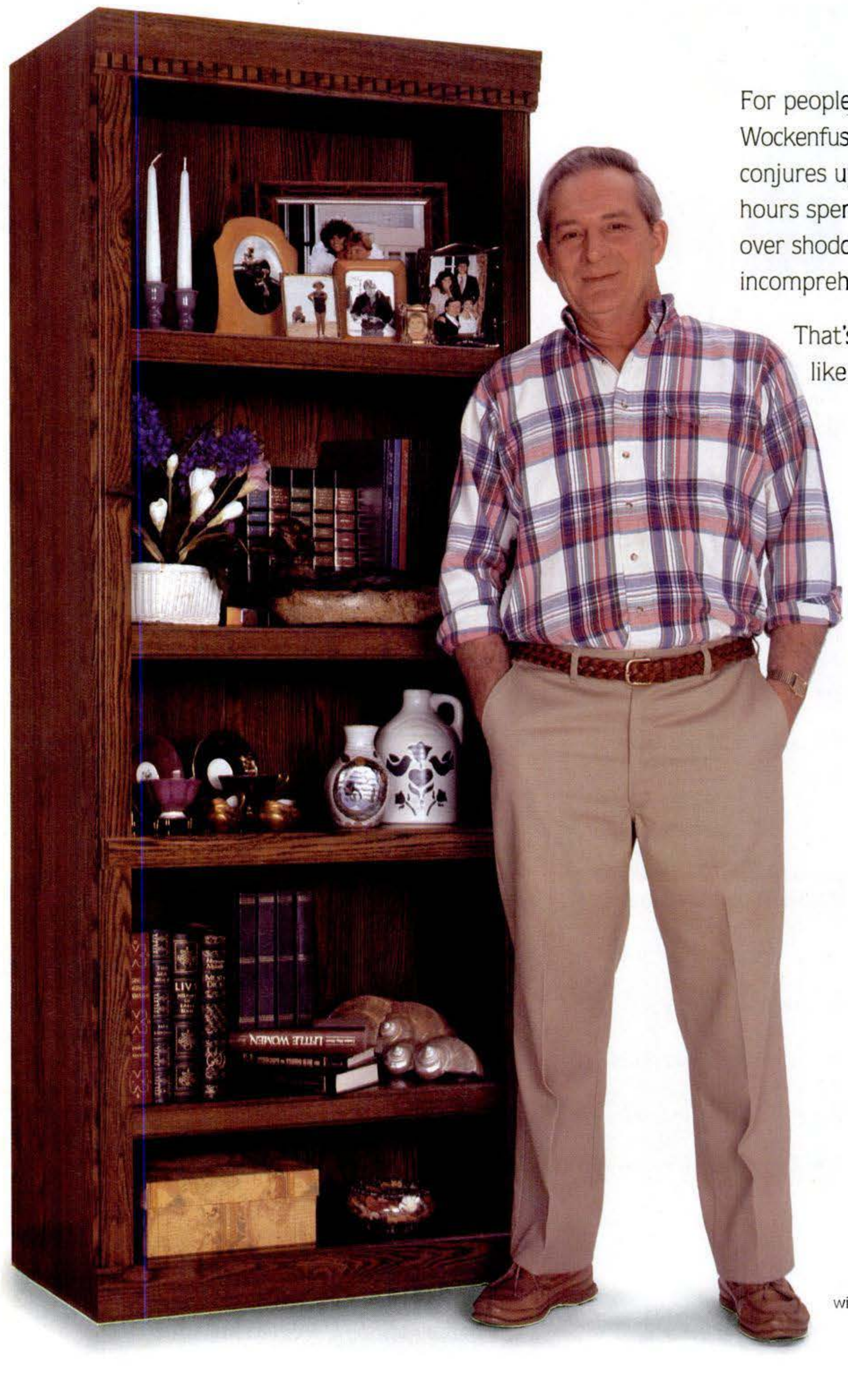

For people like Jack and Ann Wockenfuss, "ready-to-assemble" conjures up images of long hours spent muttering angrily over shoddy, ill-fitting pieces and incomprehensible directions.

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Jack Wockenfuss
with his Library #2985
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Ann writes: *"My husband was not happy that I had purchased unassembled furniture ... like Christmas Eve, he thought that there certainly would be parts missing and the directions would be so complicated he couldn't read them. To his surprise every part was included, and the directions were simple enough that even I could read them. He enjoyed putting the pieces together and there were no fights, and no bad words spoken in regard to the quality of your product."*

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More smart, practical, Sauder furniture. Shown here, part of the Princeton Collection.

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ELECTRONICS

EDITED BY MICHAEL ANTONOFF

R & D

TAPING TWO SHOWS AT THE SAME TIME

When Jack Ezra, cofounder of 3-D Video Plus in Kent, England, told me he had a prototype device that would enable a VCR to record, on the same length of a standard video tape, two programs being broadcast simultaneously, frankly, I was skeptical. I changed my mind, however, when I saw the device in action. Though the resulting images on playback were not as sharp as those from a conventional home recording, the dual-program recording capability would definitely be worth the tradeoff.

Ezra's box tunes in two channels and combines them as one. You record this hybrid signal through your VCR's auxiliary source jacks. So, for example, you'd be able to leave your VCR unattended on a Tuesday night and still be able to tape both "Home Improvement" and "Frasier," even though the programs compete head-to-head. If you were at home, you'd be able to tape both while watching yet a third program.

The box grabs separate video signals from each of two channels and records them on a single standard cassette. Upon playback, the viewer chooses one program at a time.

MARINA S. SIMKIN

The device works by rapidly interspersing signals from two channels and fooling the VCR into recording them as one. Upon playback, the box uncouples the mixed signal into its component channels. You watch one program, rewind the tape, then flip a switch to watch the other. Degradation does occur in action sequences like car chases, and you'll see some blurring. The box only works with stereo VCRs because one program's audio is shunted to the left channel while the second program's audio goes to the right channel.

Ten years ago, electronics giant Philips came out with a twin-track recorder called the Videosystem 2000. It was so expensive to make that the company withdrew it. Ezra admits that his add-on device will have to cost less than a VCR, or people simply will buy a second recorder. If his talks with Japanese manufacturers are successful, you could see Ezra's device or VCRs with the feature built-in by the end of this year.—*Suzanne Kantra*

HANDS ON

SONY'S MAGIC LINK

Personal Digital Assistants, those petite pen computers exemplified by Apple's Newton, failed to catch the public's fancy partly because of poor handwriting recognition—like when my boss penned his name, "Fred," and Newton understood it as "fired."

Now, Sony has introduced the Magic Link PIC-1000, a device that the company is not even calling a PDA but, rather, a Personal Intelligent Communicator ["Best of What's New," Dec. '94]. Magic Link doesn't attempt to understand penmanship. All scribble is treated as a drawing. If you want to input names and phone numbers or write e-mail messages, you tap an on-screen keyboard and hear the acoustic accompaniment of typing. You can also use a finger or retracted ballpoint, or if you want to achieve any reasonable speed, Sony's optional $130 keyboard.

Magic Link is the first device to implement the Magic Cap operating system. A similar device, Motorola's Envoy, also should be available by now. The interface shows a desktop, hallway, and buildings. Ironically, messages I hadn't properly stored began to pile up as postcard-like icons, and it wasn't long before my electronic desktop became as cluttered as my real desk. That's when I learned to drag items to a garbage truck icon, a function synchronized to the sound of sucking.

Magic Link and its desktop—before you clutter it up.

Magic Link leads new users through tutorials and sets them up with e-mail accounts to America Online and AT&T PersonaLink, two services accessed through the device's built-in modem (9,600-bps fax and 2,400-bps data). Daily news and stock summaries are available.

Magic Link can be used as a remote control for Sony appliances. For example, I ejected the five-disc tray on my CD player. Like Newton, you can beam messages to nearby Magic Links. A built-in microphone lets you annotate text with five seconds of audio, but that ravages the paltry half-megabyte of storage that's included. If you must talk, find a phone jack. Even without a phone, an $80 telephone headset facilitates voice calling.

There are some communications shortcomings. Unlike Hewlett-Packard's less expensive HP 200LX pocket organizer, Magic Link can't receive faxes. And unlike Envoy, Magic Link must be tethered to a land line. (A pager card is $250.)

Magic Link's non-backlit screen is a strain to read in subdued lighting, as I discovered on a recent airplane flight and at home. The base model lists for $995, but you can easily spend another $500 to get the unit fully equipped (a rechargeable battery adds $70; a crucial 1MB storage card, $220; a cable and software to connect to a PC, $100; a printer cable, $150). Value seekers would do better shopping for a subnotebook computer.

Magic Link's greatest asset is the easy-to-learn and graphically stunning Magic Cap software. Devices like this are clearly the wave of the future, and Sony's first attempt at a personal data communicator suggests the direction of better ones yet to come.—*M.A.*

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VIDEO GAMES

BRINGING 3-D TO A 2-D WORLD

With 32- and 64-bit video game machines likely to become dominant, 16-bit games would seem to be on their last gasp. In a bid to revive interest in the current Nintendo system, Rare Ltd., a British developer, is bringing 3-D characters to a game-play world still in 2-D in Donkey Kong Country, being released this winter.

This use of 3-D computer modeling is a first for the 16-bit world, and the improvement in graphics is readily apparent. Action characters and even elements like plants and rocks are created through 3-D computer modeling techniques. Objects reflect light and cast shadows, and because the objects don't stop at the edges but continue beyond your sight, you'll see the rounding of a leaf or the curve of

Textures, photographed from zoo animals, put flesh on the wire frame of Donkey Kong.

Ditty Kong's cap without the usual chunkiness.

To create an object, Rare's programmers start with 3-D wire-frame models on a workstation. They add textures to the frames—such as scanned images from grass and trees that surround the Rare facility. Main characters are animated, and their movements, such as the walking gait of a rhino or Donkey Kong's roll, are stored as a series of 3-D snapshots that run in a continuous loop like a flip-book.

Graphics will be created similarly for Nintendo's next system, the Ultra-64. But unlike today's 16-bit platform, characters will also appear to move closer to or farther away from you.—*S. K.*

VIRTUAL REALITY

BREAKTHROUGH HAND CONTROLLER

I align the biopsy needle with a small hole in the skull. At first there's resistance, but then I feel a "pop" as the needle slides into the brain. I probe several inches into brain tissue with little resistance. Suddenly, I hit a hard, spongy object. I've found the tumor.

No, I'm not a brain surgeon, and I'm not operating on a real patient. What I'm doing is testing the Phantom, a device invented at the Massachusetts Institute of Technology's Artificial Intelligence Laboratory that enables you to feel virtual objects with your fingertips.

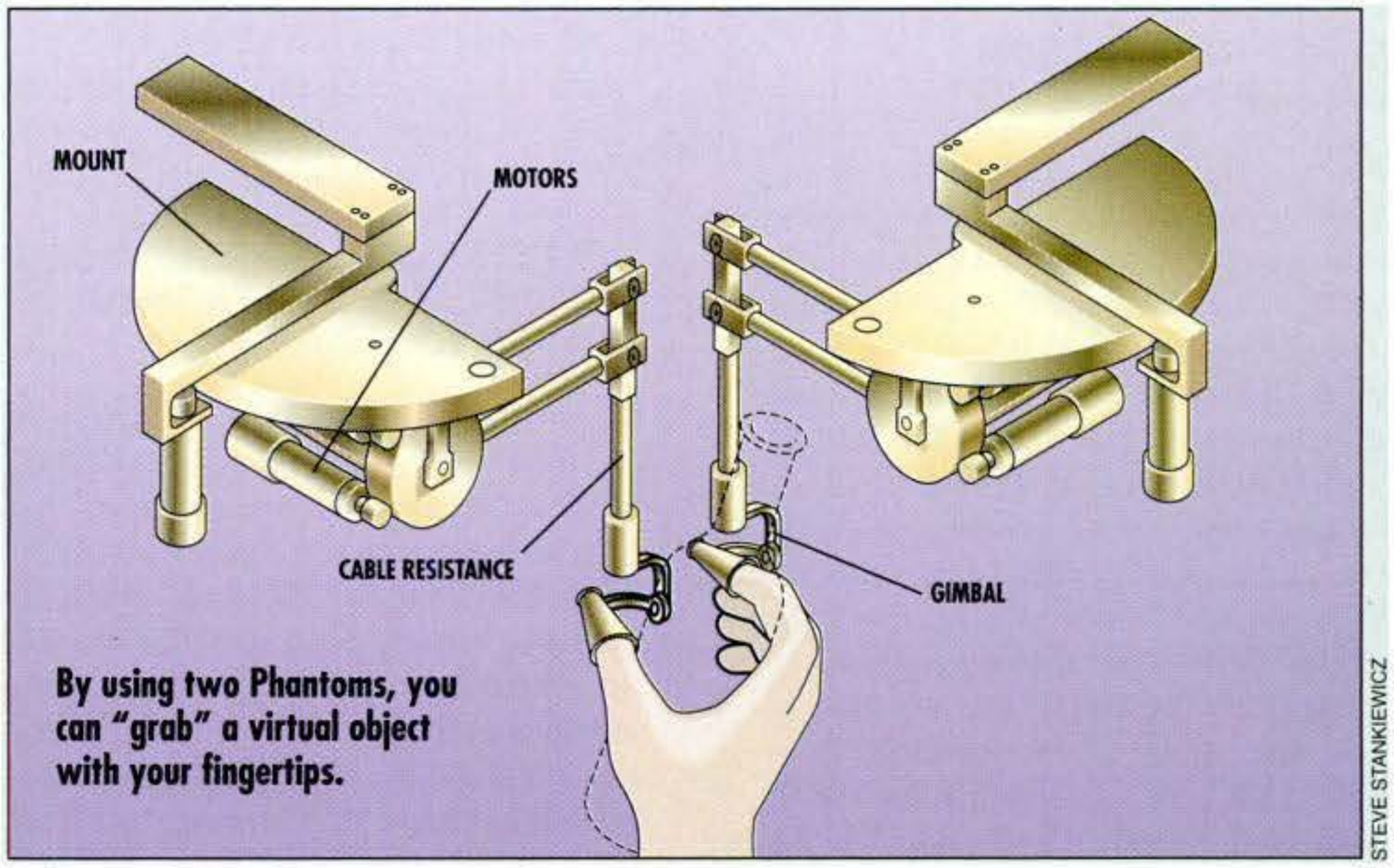
The Phantom consists of a finger thimble mounted on the end of a small robot arm. When the thimble hits a position corresponding to the surface of a virtual object in the computer, three motors generate forces on the thimble that imitate the feel of the object.

"What the computer monitor is to vision, the Phantom is to touch," explains student Thomas Massie, who designed Phantom with his adviser, research scientist Kenneth Salisbury. The Phantom can duplicate all sorts of textures, including coarse, slippery, spongy, or even sticky surfaces. It also reproduces friction. And if two Phantoms are put together, a user can "grab" a virtual object with thumb and forefinger.

Although other companies have also devised interfaces for virtual touch, experts say the Phantom is less expensive and simpler. Custom-built Phantoms cost $19,500, compared to $50,000-plus for other devices. Significantly, Massie says his contraption would be no more expensive to mass-produce than a camcorder.

Researchers are using the Phantom for surgical training, prototyping, and drug design. But Massie imagines broader applications, such as encyclopedias that allow you to touch ancient artifacts. The blind could even employ Phantoms to "feel" computer icons.

One drawback is that the Phantom sometimes overstimulates peoples' imaginations. "We had to do away with some demos that were making people think unintended thoughts," Massie acknowledges. Nevertheless, it won't be long before the sex industry figures out a way to use this.—*Robert Langreth*



By using two Phantoms, you can "grab" a virtual object with your fingertips.

STEVE STANKIEWICZ

CELLULAR PHONES

THANK YOU FOR NOT CALLING

Lately, smokers who rush to the theater entrance at intermission have company: cellular phone users. Being forced to sit quietly in a phone-free zone when one has the urge to call or be called takes self-control. When that fails, one risks tarnishing the image of mobile callers everywhere.

To help raise public awareness about electronic do's and don'ts, the Paging Services Council, a trade group, has issued a brochure called the Electronic Etiquette Guide. Some of its tips rely on common sense ("Respectfully refrain from cellular use during concerts, church services, movies..."), but others take advantage of technological solutions ("Use vibrating pagers to eliminate untimely beeping...").

You may obtain the free brochure by writing to the Council at Box 32229, Washington, DC 20007-0529.

Oh, and if you do find yourself sitting next to someone with a cellular phone as the lights dim, it's OK to preempt a potential disturbance by remarking, "Thank you for not keeping it on standby."

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New Technology Improves Sleep Quality

Chances are, you need better sleep. Thanks to advances in sleep surface technology, now you can get it!

America has become a nation of the chronically sleep-deprived. The Better Sleep Council reports that over the past 20 years, we Americans have added around 158 hours, or nearly an entire month each year, to our job schedules. That's not to mention the time we spend working hard to care for our families and homes. Sleep deprivation is caused by both lack of time spent sleeping and poor quality sleep. Sound familiar? Then you owe it to yourself to read on!

SLEEP DEPRIVATION CAN BE DANGEROUS

According to the AAA Foundation for Traffic Safety, falling asleep at the wheel is second only to alcohol consumption as a cause of automobile accidents, claiming as many as 6,500 lives every year. Disrupted sleep and sleep disorders cost American businesses billions of dollars annually in lost productivity, industrial accidents and higher medical bills. Lack of sleep also was implicated in the Exxon Valdez oil spill, the space shuttle Challenger disaster and the nuclear accident at Three Mile Island.

Loss of sleep during the night is responsible for increased vulnerability to illness, a tendency to nod off at work the next day, and even loss of creativity and clarity of thinking, say British researchers. Power tools can become dangerous weapons in the hands of someone who is not well rested. And almost everyone is familiar with the physical aches and pains that occur because of poor quality sleep.

DO YOU NEED MORE SLEEP, OR JUST BETTER SLEEP?

On the average, most adults require seven and a half to eight hours of sleep per night, and a full cycle including *deep* sleep is required for us to feel adequately rested in the morning. Any number of factors can interfere with deep, nourishing sleep – including cigarette smoking, worry, a noisy environment and physical discomfort.

Only air-cushioned support has been proven to positively affect all three factors that determine the quality of sleep: spinal alignment, pressure points and physiology.

We try remedies from pain medication and sleeping pills, to chiropractic care and self-relaxation techniques in order to get better sleep and rid ourselves of morning aches and pains. But new sleep surface technology offers a simpler solution for many people who toss and turn.

THE FIRST REAL BREAKTHROUGH IN SLEEP SURFACE TECHNOLOGY IN OVER 100 YEARS

Even if you just bought a new bed, you may be sleeping on an antiquated surface! Developed a century ago, innerspring mattresses create pressure points that interfere with total relaxation. Waterbeds made a big splash in the '60s, but even those labeled "firm" produce a hammock effect, causing the spine to curve unnaturally. Fortunately, a new technology has come through test after test with flying colors: Select Comfort Air Sleep Systems™.

The Select Comfort Air Sleep System uses air, which, unlike metal coils or water, distributes body weight more evenly and provides better support.

While it looks like a traditional mattress on the outside and even fits standard sheet sizes, the Select Comfort system is completely unique on the inside. Air is captured inside innovative "I-beam" chambers that contour to the body, support the spine, eliminate pressure points and evenly distribute weight for better sleep.

What's more, each side of the Select Comfort Air Sleep System is independently adjustable – with a remote hand control that digitally tells you the firmness level that's perfect for you. And, you can let air in or out to change the mattress firmness, depending upon how your body feels each night. This is essential for couples, because two people of different shapes and sizes cannot sleep on the same surface and both be as comfortable as they should be to achieve the best possible sleep.

MADE-IN-MINNESOTA QUALITY

Select Comfort Air Sleep Systems are manufactured in Minneapolis, Minnesota, and tested for comfort and durability by independent laboratories. Well on its way to becoming a worldwide leader in state-of-the-art sleep systems, Select Comfort currently is the fastest growing company in America's bedding industry, and has earned 22 U.S. patents.

LIGHTWEIGHT AND EASY TO SET UP YOURSELF

The Select Comfort Air Sleep System is so lightweight, it can be delivered via UPS in one carton. Following the simple instructions, one person can set up the system at home, usually in 30 minutes or less. An attached electronic air pump fills the mattress with the right amount of air, and then hides out of sight under the bed. Dual controls allow each sleeping partner to adjust the sleep surface to their desired firmness.

TRY SELECT COMFORT RISK FREE FOR 90 NIGHTS

Thousands of people from coast to coast already own a Select Comfort Air Sleep System. You can try one, too, protected by a "90 Night No Risk" guarantee and a 20-year product warranty. Call our sleep consultants and ask them about your particular sleep needs. They can answer all your questions and help you better understand how you can benefit from a Select Comfort Air Sleep System.

For a free brochure and introductory video, call 1-800-831-1211, Dept. 3732.

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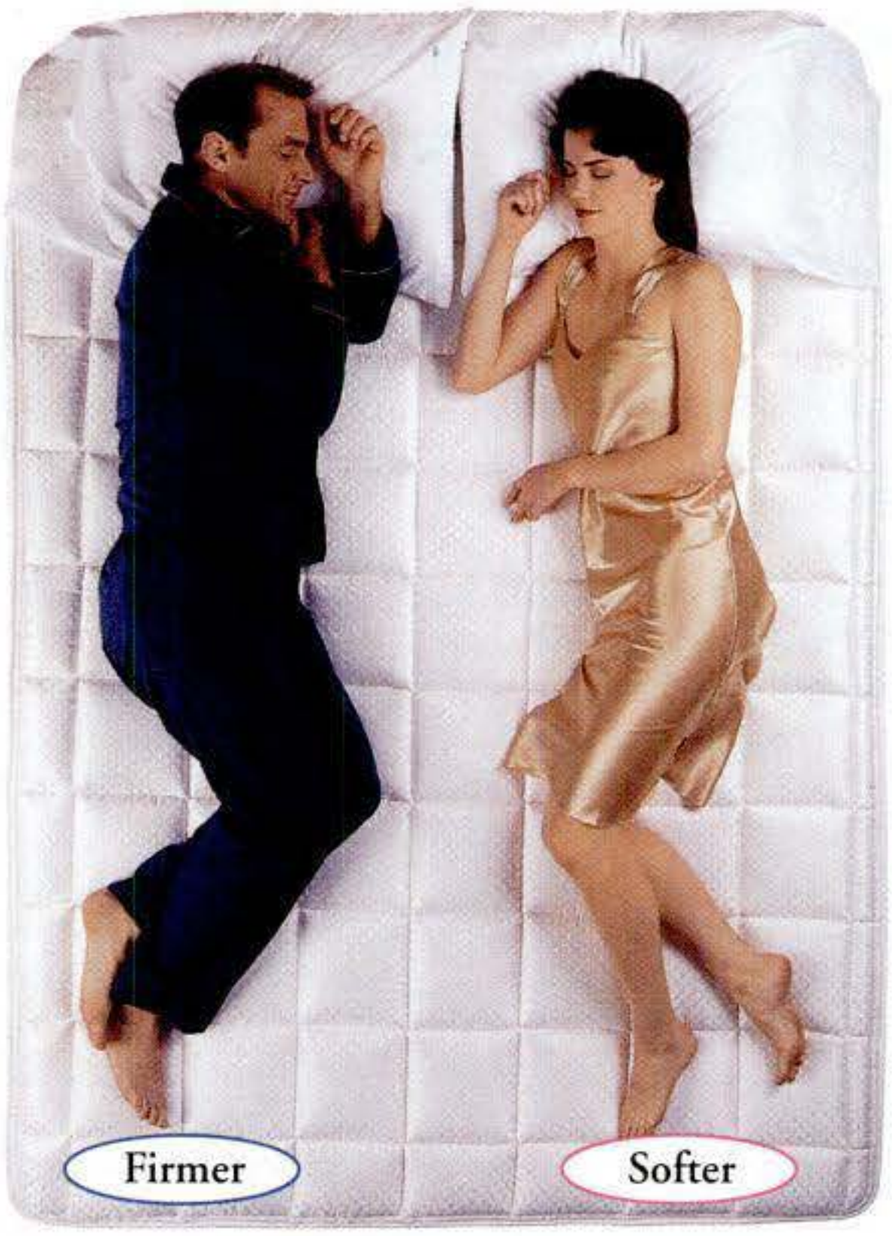
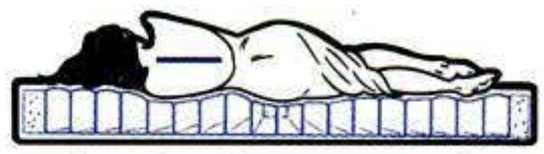
Get The Best Night's Sleep Ever!

Frustrated With The Quality Of Your Sleep?

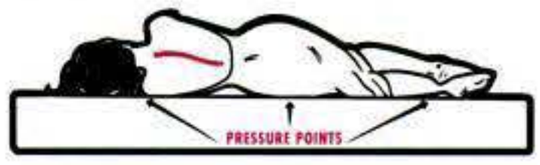
Do you toss and turn at night? Can't seem to find a comfortable position? Does your back ache when you awake? These are signs that your metal coil mattress or waterbed isn't supporting you properly and isn't right for your body. Select Comfort can help you sleep better with a revolutionary sleep system that's so comfortable and supportive, it's recommended by doctors.



With Select Comfort, you each get exactly the firmness you need.



Select Comfort's patented air design conforms to your body shape for relaxing sleep and perfect spinal support.



Metal coil mattresses support only the firm parts of your body, creating pressure points, and uneven spinal support.

You Control The Firmness

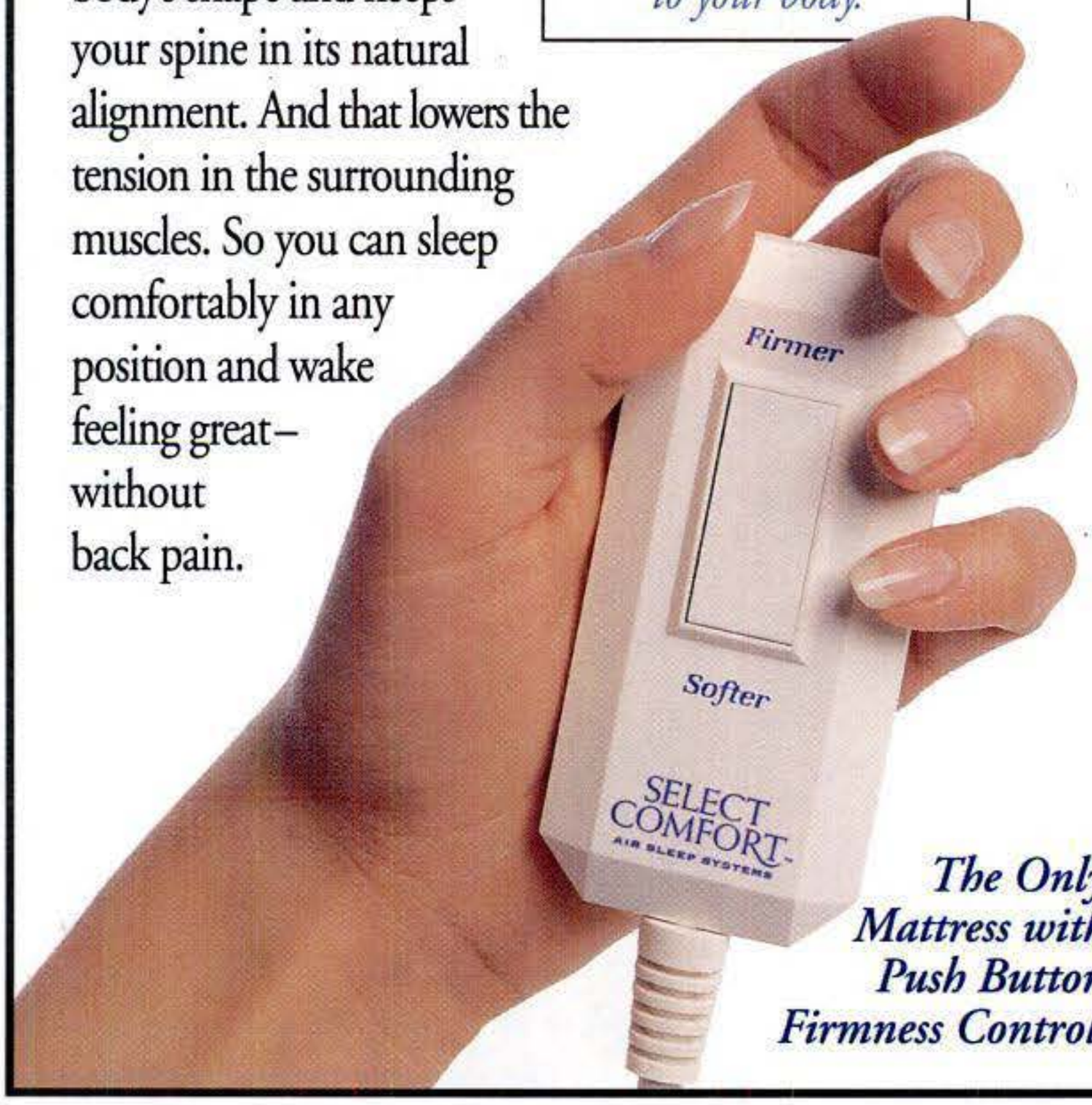
With Select Comfort, you can change the firmness depending on how your body feels each night. Go from extra-firm to extra-soft, simply at the touch of a button. In fact, the firmness adjusts independently on each side of the bed so you and your partner can get custom support without compromising comfort or quality of sleep.

Customize the firmness of each side of the mattress.

Sleep Better On Air

A Select Comfort Air Sleep System doesn't rely on springs or water. Instead, it supports your body perfectly on a cushion of air. Air is better because it gently contours to your body's shape and keeps your spine in its natural alignment. And that lowers the tension in the surrounding muscles. So you can sleep comfortably in any position and wake feeling great– without back pain.

Select Comfort contours to your body.



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HANDS ON

DIGITAL CORDLESS PHONES GO FURTHER

BY MARK FLEISCHMANN

A new generation of cordless phones promises greater range and clearer sound than ever before. These digital "spread spectrum" devices divide the signal among several channels at once, using a newly sanctioned slice of the airwaves in the 900- to 928-megahertz range. But are they worth the extra cost?

To find out, we subjected three phones to the hostile telecommunications environment of Manhattan: the Cincinnati Microwave Escort 9020, Cobra CP-912, and Uniden Extend-A-Phone EXP 9200.

All three phones cycle among 100 reception channels and offer basics such as redial and memory dial. The Uniden also incorporates two-line operation, three-way conferencing, intercom capability, and a second keypad on the base. The handsets weigh about 13 ounces each. Though the Cobra is black and the Escort white, they're very similar, since Cincinnati Microwave also makes the Cobra model.

There were four tests. All took place with the base of each phone placed on a bedroom windowsill—a central location in the tester's apartment that also allowed partial line-of-sight to the outdoors. Local calls were placed to the POPULAR SCIENCE office and to a number that featured voice menus.

First, the handsets were carried around the apartment and required to beam signals through and around thick plaster walls. All the phones had excellent sound quality.

Next, the phones were carried down four flights of stairs and around a large lobby, requiring them to penetrate layers of steel-reinforced concrete. All three aced this second test, although on the stairs they did experience minor interference from the electrical workings of the adjacent elevator shaft. All could be used anywhere in the lobby.

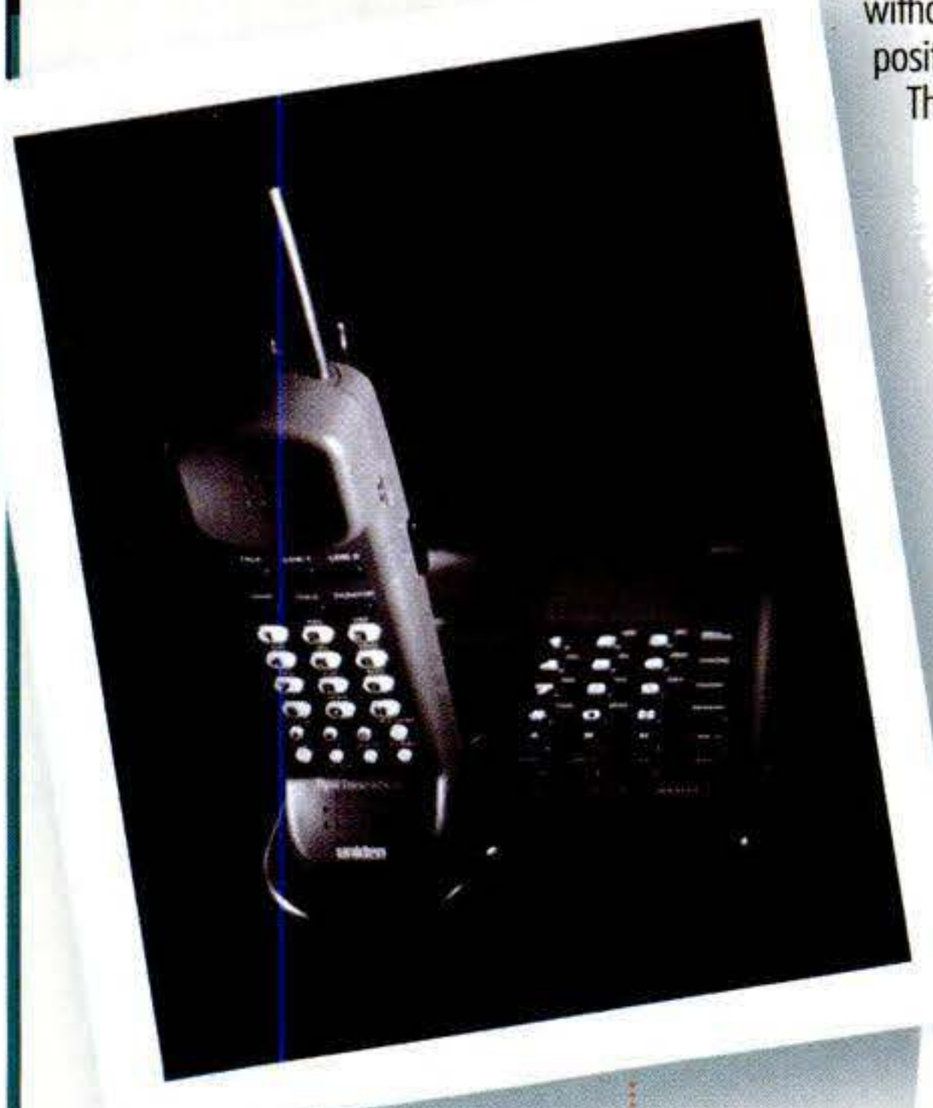
The third test was the cruelest: From a position outdoors in front of the window where each transmitter-base sat—four stories up, at the back of a 40-foot courtyard—each handset was carried past the courtyard and up the street, where it had to penetrate buildings without line-of-sight positioning.

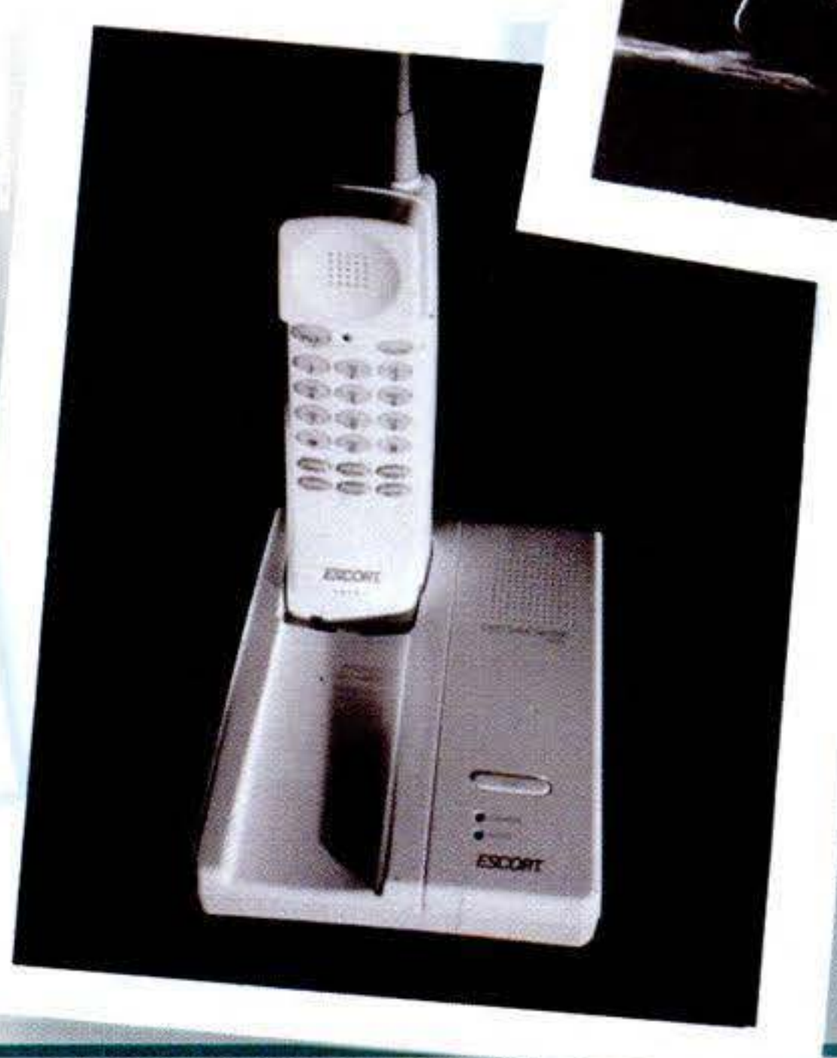
The Cobra went 2½ blocks from the courtyard before losing the signal more than half the time in a flurry of clicks and dropouts. The Uniden—the only model that automatically switches to another channel when noise becomes overwhelming—frantically cycled among channels, but to no avail after two blocks. Manually switching channels on the Escort did no good after two blocks.

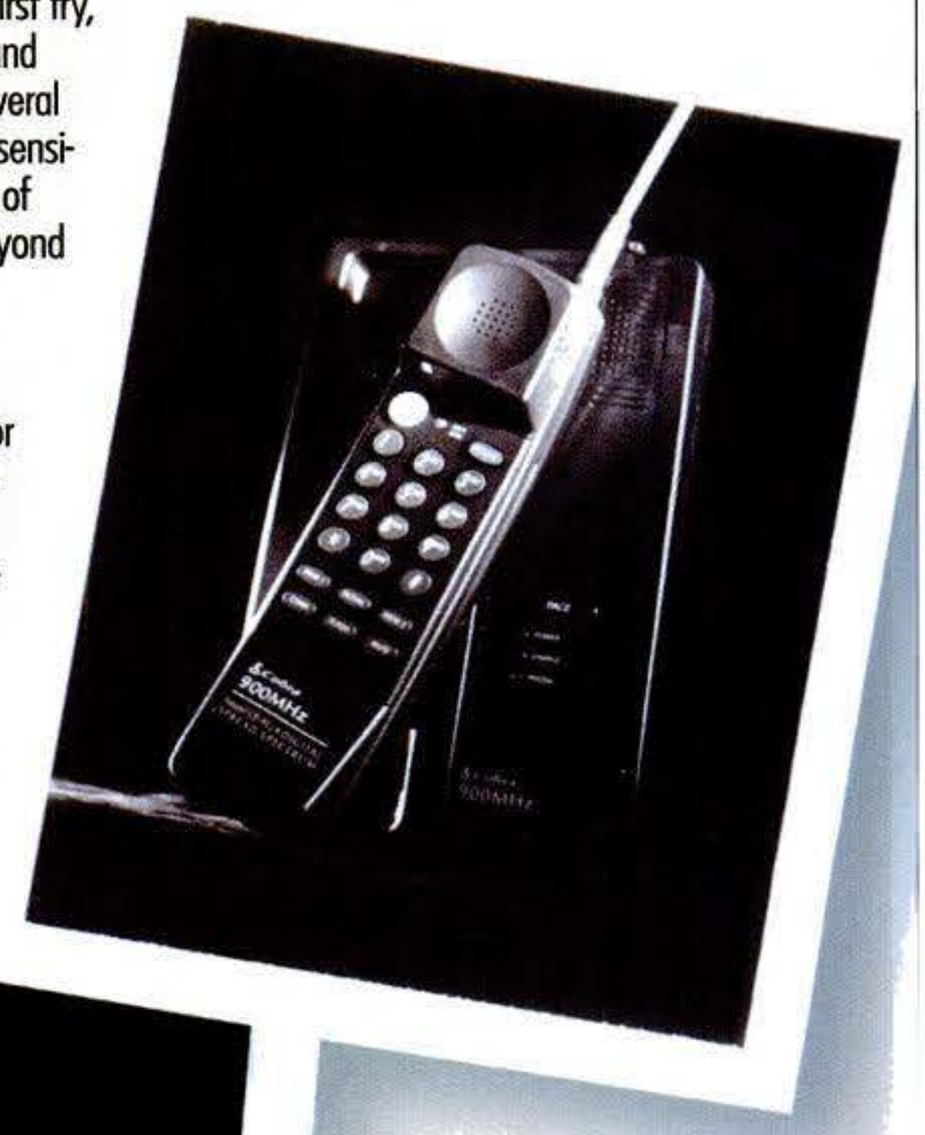
Finally, the phones were carried downhill into a park, partially obstructed by trees. Calls were placed from the banks of the Hudson River, 1,200 feet from the transmitter.

Surprisingly, all three successfully placed calls from a riverside sweet spot. The Cobra summoned a dial tone on the first try, though the Escort and Uniden required several attempts. All were sensitive to movements of even a few feet beyond the line-of-sight. Dropouts were frequent. The longest was five seconds for the Uniden; the Escort seemed especially quiet. The automatic-scanning Uniden flipped through a dozen channels. Switching the channel manually a smaller number of times sufficed for the Cobra and Escort.

Also subjected to the same tests were three analog cordless phones. The Sony SPP-ER1 ($359.95) and General Electric's 2-9910 ($229) use the same 900MHz frequency range as the digitals. Indoors, both performed almost as well as the others; outdoors, they exhibited loud hissing distortion except when used directly in front of the transmitter's perch, although the Sony did work, albeit noisily, well beyond the line-of-sight position. The indoor range of a Cobra CP-705, a traditional 47MHz analog model, was marginally more limited; outdoors, it was useless. Unlike the digital phones, none of the analog phones could summon a dial tone 1,200 feet into the park. The distinction between 900MHz and 47MHz seems to matter less than the differences between analog and the superior digital technology. PS







From the far left are the Cobra CP-912 ($299.95), Uniden Extend-A-Phone EXP 9200 ($589.95), and Cincinnati Microwave's Escort 9020 ($299). The Uniden contains features appropriate for a home office.

PHOTOS BY JOHN R. CARNETT

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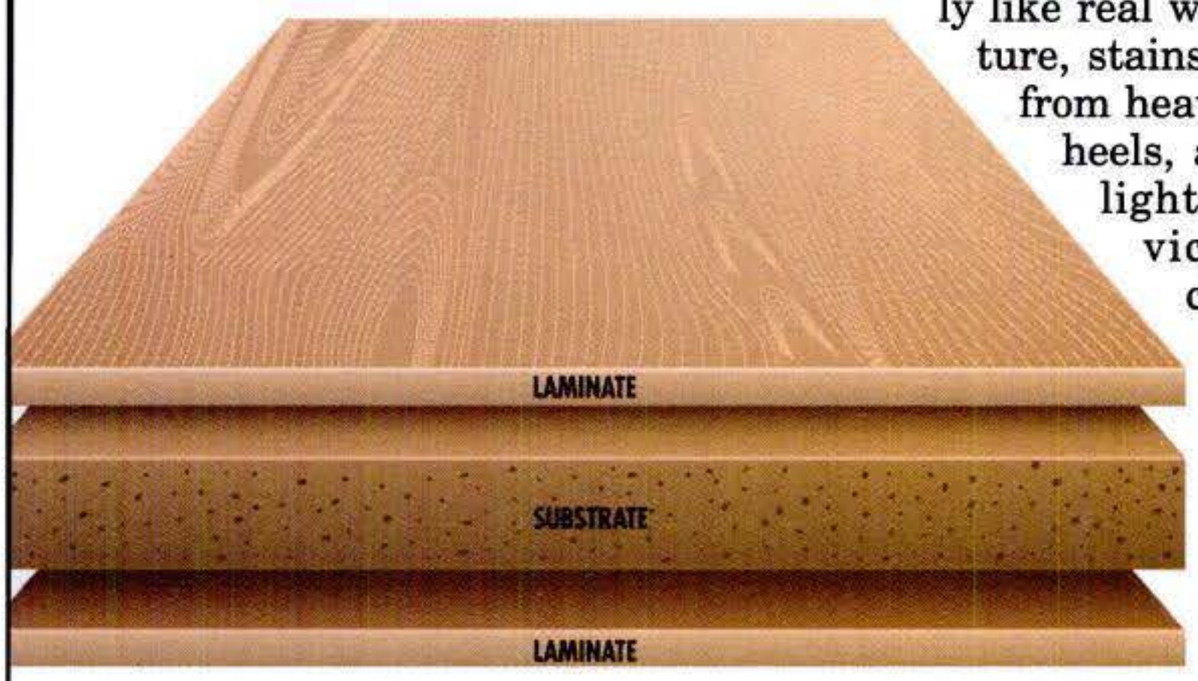
HOME TECHNOLOGY

EDITED BY JUDITH ANNE GUNTHER



A European flooring system combines laminates with a strong substrate to resist dents and spills.

COMPOSITES

PLANKS OF STEEL

I don't smoke," said Hans Johansson apologetically as he lit a cigarette and set it, smoldering, on a sample strip of maple flooring. It was his way of demonstrating the durability of a hardwood-floor look-alike, a high-pressure melamine laminate plank called Pergo. Within minutes, the cigarette had left a nasty-looking stain. Johansson wiped it away with a daub of nail polish remover.

High-pressure melamine laminate flooring has been popular in Europe since it was first produced by the Swedish company Perstorp Flooring 15 years ago. Now Perstorp has begun distributing Pergo in the United States; another company, Seaton Sales of Woodmere, N.Y., distributes a similar version called decoFlor, manufactured by the Portugese company Sonae. The flooring looks convincingly like real wood, but resists moisture, stains, burns, indentations from heavy furniture and high heels, and fading from sunlight. Johansson, senior vice president of the company, claims Pergo is almost 20 times more durable than laminated kitchen countertops.

Each plank measures 47 inches long, eight inches wide, and ¼ inch thick. It begins with a substrate; Pergo uses a particleboard base, while decoFlor uses hardboard. To this base is bonded a high-pressure melamine laminate made of several layers of resin-treated paper, plus paper bearing a wood-grain image, and topped with a melamine-resin sheet, all bonded under heat and pressure. A second layer of laminate is bonded to the substrate's underside to help limit warping and bowing.

Because the plank edges are tongue-in-groove, they fit together seamlessly. The planks can be laid directly over sheet vinyl, linoleum, or concrete, but they should not be glued or otherwise attached to the existing floor. Prices start at about $3 per square foot for decoFlor, and $3.50 to $4 per square foot for Pergo.

MATERIALS

SUPER-DUPER LUMBER

An enterprising graduate student has patented what the American Institute of Timber Construction calls the first new technology for glued laminated beams in 40 years.

So-called "glulam" beams are usually made by stacking and gluing together thin pieces of lumber. One of the new beam's bottom layers is made of high-strength, fiber-reinforced plastic, which results in a beam that's as much as 115 percent stronger than a conventional one, so it can be made smaller and lighter and be produced with inferior grades of lumber. The new process lowers costs by 25 to 40 percent.

The beam was developed by Dan Tingley, who was completing a degree in engineering and forest products at the University of New Brunswick and Oregon State. It took Tingley years to find a high-strength plastic that would deform under load at the same rate as wood, and that could be glued without costly, hard-to-use epoxies. He succeeded by mixing carbon or aramid fibers (used in bulletproof vests) in a plastic matrix.

Tingley has licensed American Laminators of Drain, Ore., to make the new beams. But this may be just the beginning. Robert Leichti, the Oregon State professor who supervised Tingley's research, sees a number of potential spinoffs. Tingley and Leichti have already added plastic laminations to flanges of wood I-beams and floor trusses. Both demonstrated marked improvement in strength and stiffness.—*Charles Wardell*

SAFETY

DETECTING KILLER FUMES

Carbon monoxide, the odorless, colorless gas that killed tennis star Vitas Gerulaitis last fall, is a threat in any home heated by natural gas, oil, propane, or kerosene. A by-product of incomplete combustion, carbon monoxide bonds to hemoglobin in the blood and prevents it from carrying oxygen to cells.

The Consumer Product Safety Commission recommends that homeowners install CO detectors that emit a piercing alarm when they sense dangerous levels of the gas. Ironically, Gerulaitis' tragic death occurred as manufacturers are developing detectors with more features and better safeguards to ensure reliability.

First Alert, for example, just introduced a CO sensor that is wired into a house's electrical system but switches to a back-up battery if power is interrupted. The $70 device can be connected to as many as 12 additional detectors.

Jameson's Model 0310 indicates differing levels of carbon monoxide. If the $45 device senses the deadly gas, it sounds an alarm every 30 seconds and illuminates an amber LED. If it continues to sense CO, the product switches to a continuous alarm at 85 decibels and the LED turns red.

For use in a car, boat, or recreational vehicle, Enzone's Air-Zone II has an optional DC cord, so it can be plugged into a cigarette lighter. With an optional attachment, the $59 device will even help bring in fresh air if a garage contains high CO levels: It'll signal the garage door opener to raise the door automatically.

First Alert's carbon monoxide detector switches to a battery during power outages.

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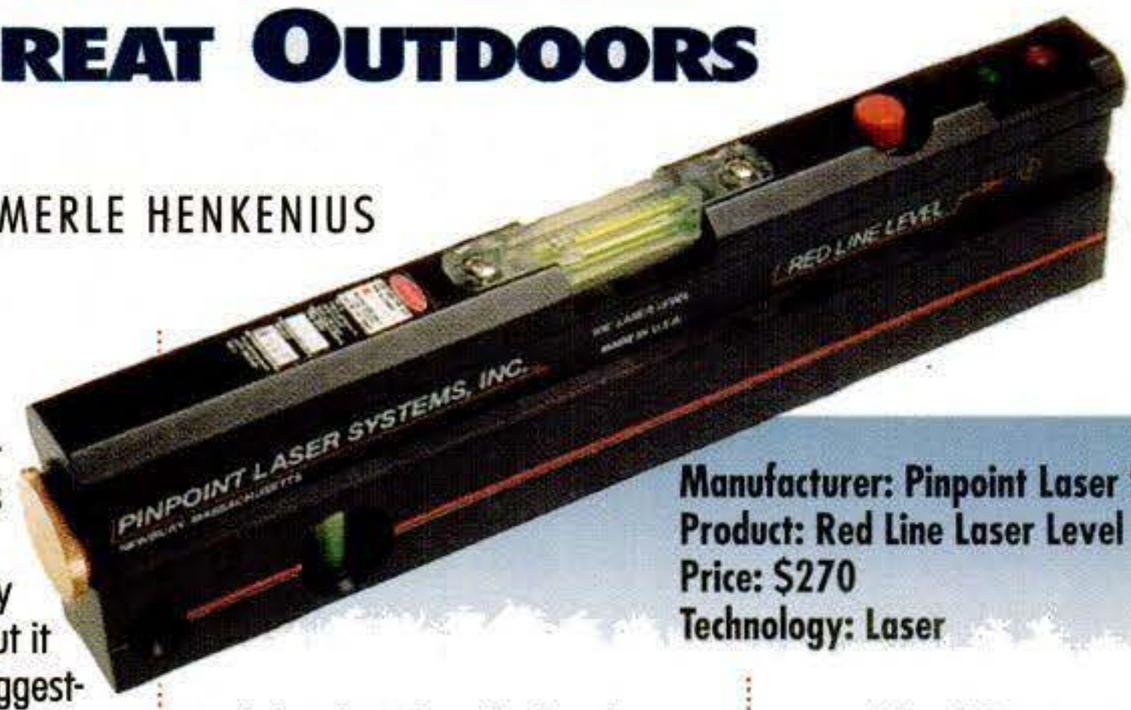
HIGH-TECH TOOLS

STAYING ON THE LEVEL IN THE GREAT OUTDOORS

BY MERLE HENKENIUS

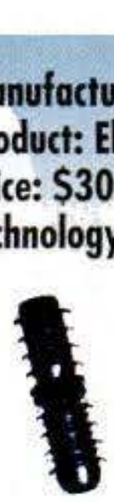


Manufacturer: Pinpoint Laser Systems
Product: Red Line Laser Level
Price: $270
Technology: Laser

Common spirit levels may be fine for jobs around the house, but what do you use when tackling larger work outside? I tested three levels that claim to handle outdoor leveling tasks that involve long distances, such as installing deck post footings or even regrading a driveway.

Included in this test are the Zircon Electra Level, the Red Line Laser Level, and Stanley's Compulevel. I used them straight from the box, with just the enclosed directions to guide me. All are designed for use by only one person.

Manufacturer: Zircon
Product: Electra Level
Price: $30
Technology: Water level



My first subject, the Zircon Electra Level, is a surprisingly simple tool. It's basically a water level, but one modestly enhanced by an electronic sensor at one end. (A water level is simply a liquid-filled hose made of clear plastic. When both hose ends are raised, water levels at each end indicate equal elevation.)

I used the Electra Level to set the height of a picket fence, marking the picket heights on posts that were already in place. After filling the hose and clamping the ends shut with the plastic clips provided, I tacked the sensor to the first post at the desired height. I then carried the working end of the hose to each subsequent post, raising it against each post until the sensor alarm sounded. I then marked the post at the water level in the hose. It was really that simple.

The Electra Level is hardly cutting-edge technology, but it performs well. And at a suggested retail price of $30, it's also affordable.

A bit more expensive—and complex—is the Red Line Laser Level, which has a familiar, spirit-level appearance. For this test, I used the tool when I was setting post footings for a large deck. The deck sits above a sloping grade, so setting proper elevations was critical. I immediately popped in two AA batteries and began using it without referring to the manual.

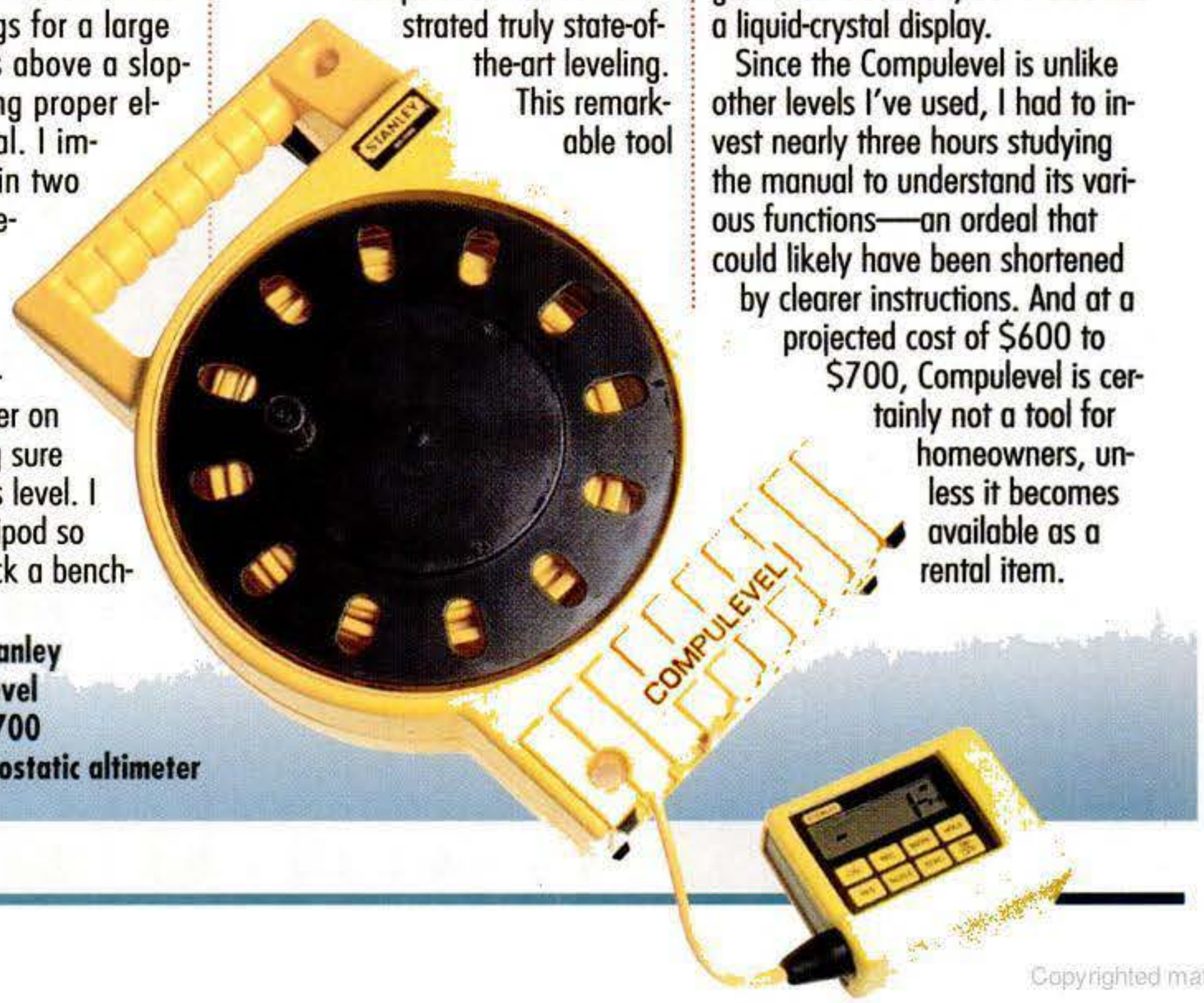
I began by mounting the Red Line laser on a tripod and making sure the device itself was level. I then adjusted the tripod so the laser beam struck a bench-mark height I'd marked earlier. Thus prepared, I set each post and focused the pinpoint laser beam on it. The beam's red dot indicated the correct height. Its spirit vial can be adjusted to yield a continuous grade slope, which would come in handy when grading a drainage area, for example. A variety of snap-in vials is also available for jobs requiring greater precision or longer range. The only problem I encountered was that direct sunlight made the beam hard to see. I solved the problem by holding a white card against the post.

Machined from solid-aluminum block, the Red Line laser has a reassuring heft. It is also water- and dust-proof, but at $270, it may not find its way into many home tool kits.

Yet, for all the high-tech reputation of lasers, it was the Stanley Compulevel that demonstrated truly state-of-the-art leveling. This remarkable tool is capable of doing much more than the other two devices. As its name implies, it has a built-in microprocessor and can also be connected to a personal computer. Not only does it precisely mark elevations and set grades, but it can also store and average field data. With a PC, it can also be used to create topographical and three-dimensional maps—even calculate the height of a nearby mountain.

Unlike the laser level, the Compulevel easily works around line-of-sight obstructions, such as trees. It consists of a base unit, which you stake in place, and a hand module that's connected to the base via a long cord. In its entirety, the Compulevel has the unlikely appearance of an electrical cord and reel. You carry the hand module from one site point to another. It beeps when it recognizes a preprogrammed elevation, but it also has a liquid-crystal display.

Since the Compulevel is unlike other levels I've used, I had to invest nearly three hours studying the manual to understand its various functions—an ordeal that could likely have been shortened by clearer instructions. And at a projected cost of $600 to $700, Compulevel is certainly not a tool for homeowners, unless it becomes available as a rental item.



Manufacturer: Stanley
Product: Compulevel
Price: $600 to $700
Technology: Hydrostatic altimeter

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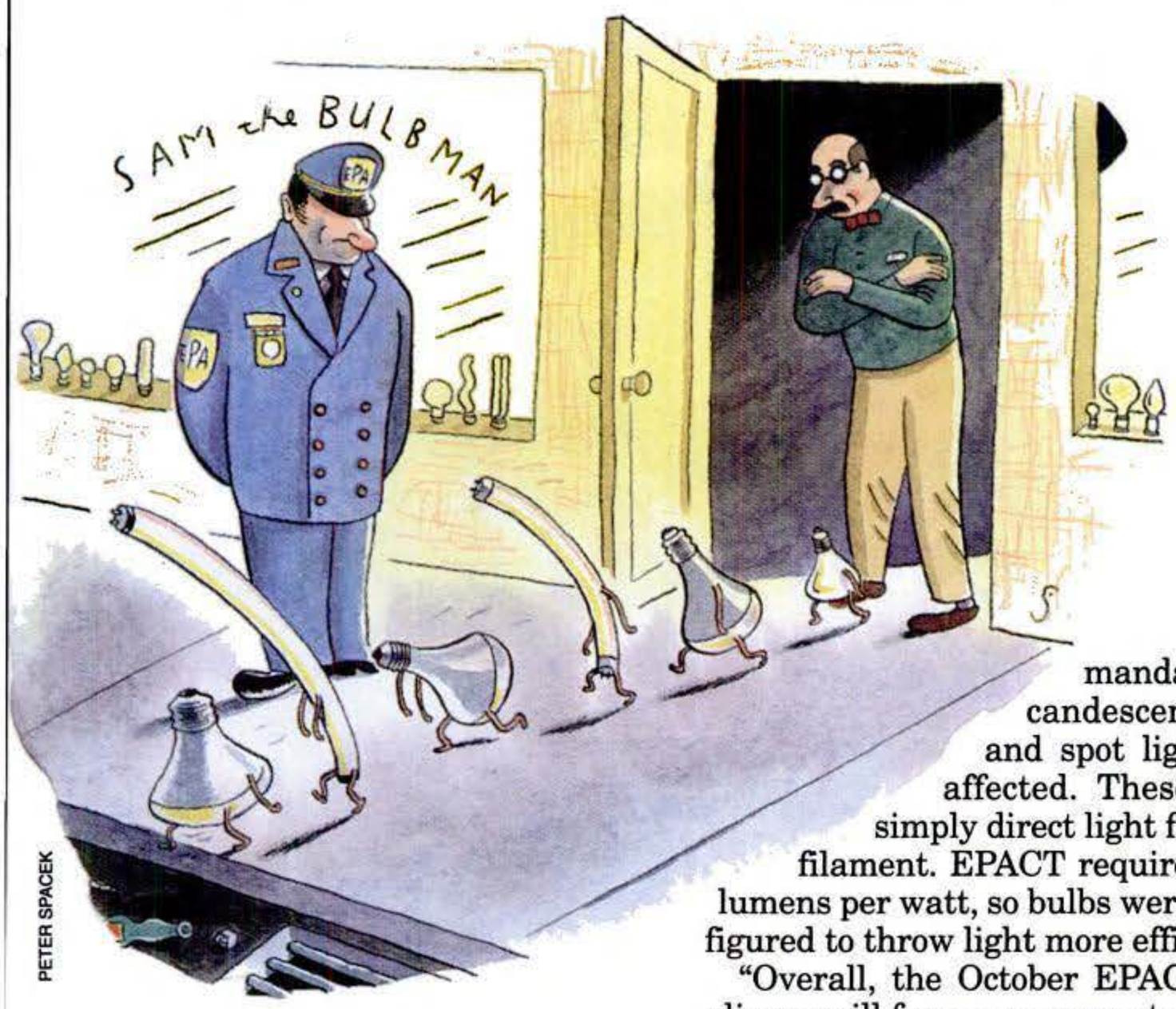

PETER SPACEK

LIGHTING

GOODBYE, OLD BULBS

Don't be surprised if some common household light bulbs disappear from store shelves this year. The 1992 National Energy Policy Act (EPACT) mandated greater efficiency in certain bulbs, and manufacturers are responding with several changes.

The popular "cool white" fluorescent bulb ("F40" or "T12") will no longer be manufactured as of October 31, 1995. It will be replaced by a triphosphor coated bulb that increases lumens (light emitted) per watt consumed. Also, it boasts better "color rendering"—how natural colors look under the light.

While energy-wasteful 75- and 100-watt incandescent bulbs escaped the mandates, incandescent flood and spot lights are affected. These bulbs simply direct light from the filament. EPACT requires more lumens per watt, so bulbs were reconfigured to throw light more efficiently.

"Overall, the October EPACT compliance will force consumers to replace popular lights with superior ones," says Robert Sardinsky, a lighting industry consultant. "The benefit is reduced lighting costs and improved performance. It's not a compromise."

The law only stops the manufacture of the older bulbs. Retailers can carry them for as long as supplies last.

Meanwhile, look for new lighting-product labeling by April 25, also mandated by EPACT. Much like the yellow energy-consumption stickers on appliances, the new labels announce light output (in lumens), energy used (in watts), and life (in hours). To save energy and money, shop for the desired lumens and pick the bulb that consumes the fewest watts. With new technologies and increased efficiencies, a higher wattage does not necessarily mean a brighter bulb.—*John D. Wagner*

CONSTRUCTION

THE LEAN, MEAN ROOF

Roofs have to fend off many things—high winds, rain, and heavy snow, not to mention the sun's hottest rays. Now a builder, a roofing contractor, and an engineer in Sacramento have teamed up to develop a roof they say is significantly stronger than an ordinary roof, and that insulates against extreme temperatures too.

Conventional roofs start with a layer of plywood that is covered with tar paper. A series of wood strips is tacked on; to these are nailed the roofing material. The Retro-Steel roof, on the other hand, begins with 20-gauge, 1½-inch galvanized steel hat channels (so called because in cross section these beams look like a top hat). These are laid directly onto the rafters. Next, a 3/32-inch thick, resin-impregnated paper with a foil backing is draped over the hat channels. More steel hat channels are then attached; the roof is finished with lightweight concrete tiles made by Monier.

Because of the inherent strength of the steel, and because everything is held together with screws instead of nails, the roof is considerably stronger than a conventional wood roof, says builder Gary Ferguson. "On a 2-by-4 wood rafter," adds building engineer Mark Schoen, "the hat channels typically add about 17 or 18 percent more load-carrying capacity."

This new roofing system, made with galvanized steel beams and a resin-impregnated paper, is both strong and energy-efficient.

In addition, the new roof helps cut heating and cooling costs. "The system becomes a natural heat pump," explains Ferguson. As sun warms the roof, air between the hat channels rises and exits at the roof peak, and cooler air is drawn in near the gutters. Schoen, who logged the attic temperatures in his house before and after a Retro-Steel roof was installed, claims the extra ventilation cut the attic temperature by 30°F in the summer. PS

ENERGY

IMMEDIATE FEEDBACK

When some residents in Walnut Creek, Calif., want to check how much electricity they're using, they won't look at the meter—they'll flip on their television set instead. About 30 homeowners are participating in a test program by Pacific Gas and Electric that enables them to get their energy information via cable TV.

The $6 million trial, a joint project between PG&E, cable giant TCI, and Microsoft, will outfit the homes with a special cable box that enables residents to access a variety of utility services. For example, homeowners will use their remote control to program certain appliances to operate when rates are lowest, review a chart depicting which appliances are consuming the most energy, or call up an estimate of their upcoming bill. Users may even be able to pay their bills electronically.

This spring, the program will expand to 1,000 homes, says PG&E's Steve Phillips. Other possible features, including home-security systems, may be added.

According to Phillips, the system's automatic meter-reading capability should help the utility save money. In addition, the features should enable homeowners to save electricity, or at least shift use to off-peak times—which could forestall the need for additional power plants in the future.

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Libyan leader Mohammar Khadafi survived the attempt on his life when U.S. aircraft attacked targets in and around Tripoli in 1986—but he got the message that sponsoring international terrorism would trigger deadly retaliation.

POPULAR SCIENCE has learned that then-secret F-117A stealth fighters were ready to take part in the strike against Khadafi's headquarters in Tripoli and were fueled, armed, and waiting to depart from an air base in the Carolinas. But an hour before they were scheduled to take off, Defense Secretary Caspar Weinberger, fearful of revealing secret U.S. stealth technology if a plane were lost, canceled the mission.

As a result, the attack was carried out, without the stealth advantage, by a force of Air Force F-111s based in England, and Navy F/A-18, A-7, and A-6 attack planes launched from aircraft carriers. One F-111 was downed by Libyan air defenses during the mission, and its bombs hit civilian areas in Tripoli; the French Embassy was among the buildings damaged. In fact, because stealth aircraft were not used in the raid, the element of surprise may have been lost.

One day, such attacks may be carried out by a smaller, more survivable force of radar-eluding attack planes derived from secret prototypes that are believed to be undergoing flight tests now. Reports from aerospace sources sketch a picture of an unacknowledged aircraft that appears to be designed for precisely these kinds of missions.

Insiders who have seen it describe a fast, stealthy swing-wing plane that looks like a cross between the current F-

SWING WING STEALTH ATTACK PLANE

Will a secret new supersonic bomber replace the aging

By STUART F. BROWN & STEVE DOUGLASS

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Air Force F-111?

Advanced jet engines, stealth technology, and wings that swing are ingredients of a mysterious attack plane. Its name? A-17 is an educated guess.

ALFRED T. KAMAJIAN

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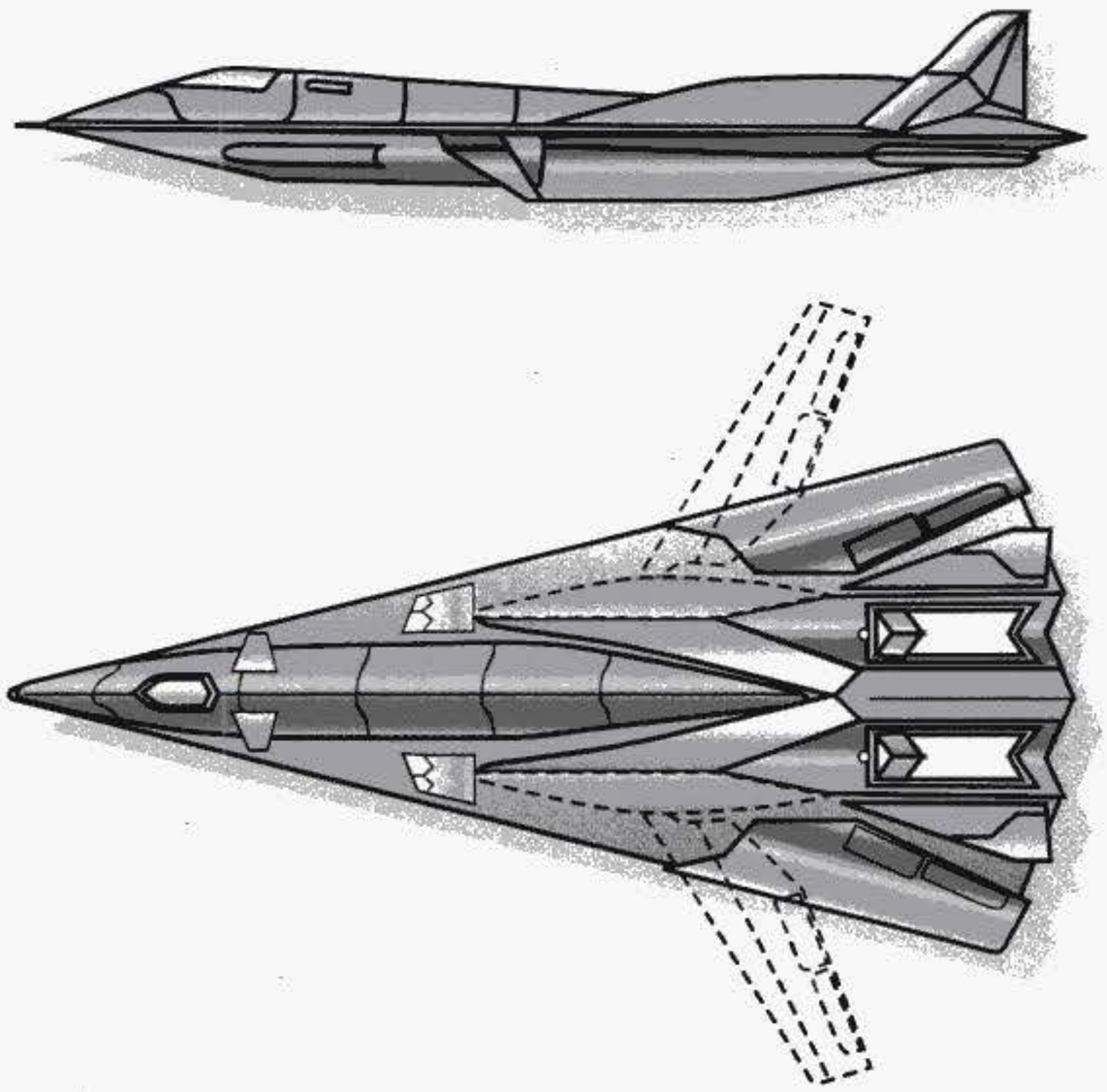
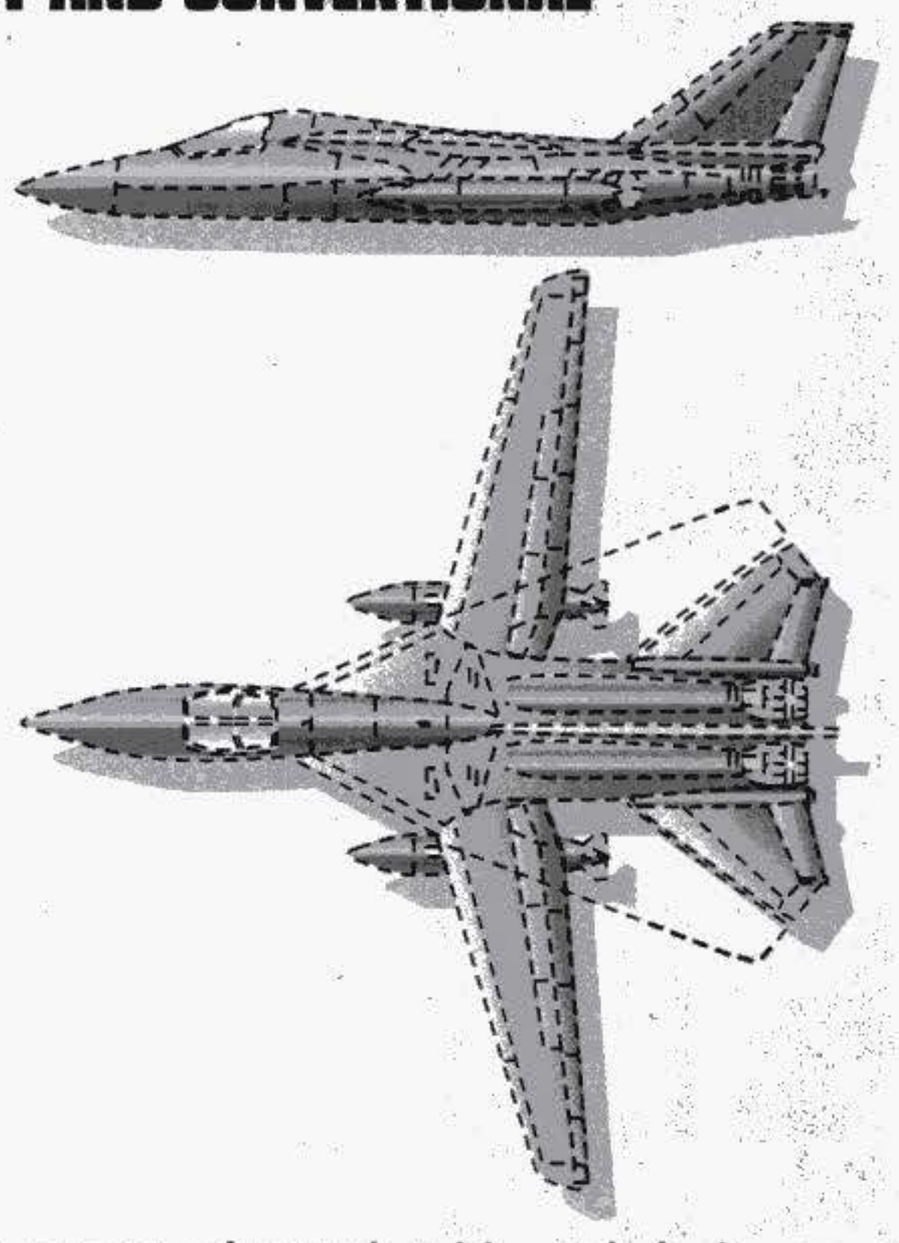
SWING-WING BOMBERS: STEALTHY AND CONVENTIONAL





The new swing-wing attack plane (left) spotted in the Southwest has internal weapons storage and engines buried deep in the fuselage to avoid reflecting radar. Troughs behind the engines foil heat-seeking missiles by blending cool air with hot exhaust. Its role is probably similar to the 1960s-designed F-111 medium bomber (right), which uses swing wings to improve takeoff and landing performance as well as cruising range.

IAN WORPOLE

111 medium bomber and Northrop's YF-23 advanced tactical fighter prototype ["Supercruisers," April '91]. High-ranking officials are said to have gathered in secure hangars at two air bases to be given a covert peek at the new aircraft after its arrival under cover of darkness.

Last September, it was observed circling high over Amarillo, Texas, for several minutes at midday. Chatter coming over a radio scanner picking up a military UHF channel sounded the alert when an airplane with the unfamiliar call sign "Omega" was overheard reporting a hydraulic malfunction. The pilot said he was dumping fuel in preparation for an emergency landing.

The cloud of vaporizing fuel formed a wide, bright contrail like an arrow that pointed out the mysterious airplane against the clear blue sky. Binoculars revealed narrower contrails streaming from two smaller, darker-colored aircraft flying in formation with the Omega aircraft. These were F-111 chase planes, using the call sign "Duke," that also were dumping fuel to reduce weight before the early return to base. Unlike the conventional tails of the F-111s, the Omega airplane's tail was serrated with three aft-facing points.

The stealthy swing-wing plane appears to be the prototype of an attack aircraft that could replace the venerable F-111—known to fliers as the Aardvark—which has been in service in several versions since 1967. Preparations for the new plane's arrival may be underway at Cannon Air Force Base in remote Clovis, N. M., where the nearby Melrose Bombing Range has been expanded, and a new restricted airspace has appeared on the latest Federal Aviation Administration pilots' charts.

As part of its post-Cold-War restructuring, the Air Force has moved the entire inventory of F-111s to Cannon from Mountain Home AFB in Idaho, and from bases in England. The flight line at Cannon is now populated with about 90 Aardvarks and EF-111 Ravens, the electronic-warfare version of the F-111.

Millions of dollars have been poured into expanding the base recently. There are newly built hangars, one of them unusually large; an aircraft painting shop; a base hospital, and extensive renovations of the flight-line facilities. Sprawling housing complexes have sprung up to accommodate the influx of personnel; the government has leased the residences for up to 20 years.

Yet against this backdrop of humming activity, the Pentagon has announced that the F-111 will be retired by the end of 1995. Altogether, the scope of the expansion at Cannon is broader than the F-111s can justify. And Air Force officials have assured the residents of Clovis that the base will continue to expand in preparation for a new mission.

Thus, the swing-wing F-111 may soon be phased out to make room for a secret swing-wing aircraft, armed with bombs and self-defense missiles, and called the A-17. In the lineup of stealth aircraft, the new bomber would carry an intermediate-size weapon payload, placing it between the Lockheed F-117A attack plane and the Northrop B-2 heavy bomber.

Why is A-17 a plausible designation? A-12 was assigned to the Navy's cancelled McDonnell Douglas "Dorito" stealth attack plane. A-13 would be seen as unlucky. A-14 and A-15 are believed to have been the other two entries in the Navy's A-12 competition. An attack variant of the F-16 already wears the label A-16. And the number 18 is taken by the Navy's F/A-18 Hornet attack fighter. Which leaves A-17 up for grabs.

Swing wings add weight and complexity to an airplane, but they also provide unique benefits. Swung forward, the wings enhance lift and reduce fuel consumption. In this mode, range is improved, and takeoffs and landings can be made from relatively short runways. With its wings fully swept back, the aircraft assumes an aerody-

[*Continued on page 86*]

REINVENTING

the TELESCOPE

BY RAY NELSON

The sun dips toward the New Mexican desert horizon, and the coyotes begin their yipping chorus. A TV camera watches me drive through a remote-controlled security gate on Kirtland Air Force Base near Albuquerque. As I climb a hill, I see a large telescope with a peculiar difference: It has no dome. Suddenly, a bright green laser beam lances into the sky from a nearby building top, like Luke Skywalker's Jedi sword.

"Star Wars" indeed. Here at the Air Force Phillips Laboratory's Starfire Optical Range, weaponry technology developed under the Strategic Defense Initiative has a new mission: helping Earthbound astronomers improve their view of the heavens. The technology, called adaptive optics, combines powerful lasers, high-speed computers, and deformable mirrors to create telescopes able to overcome atmospheric distortion.

While Starfire's primary purpose is developing adaptive optics for Air Force laser applications—including missile defense, spacecraft surveillance, power beaming, and deep-space communications—research at the facility is also helping to rev-

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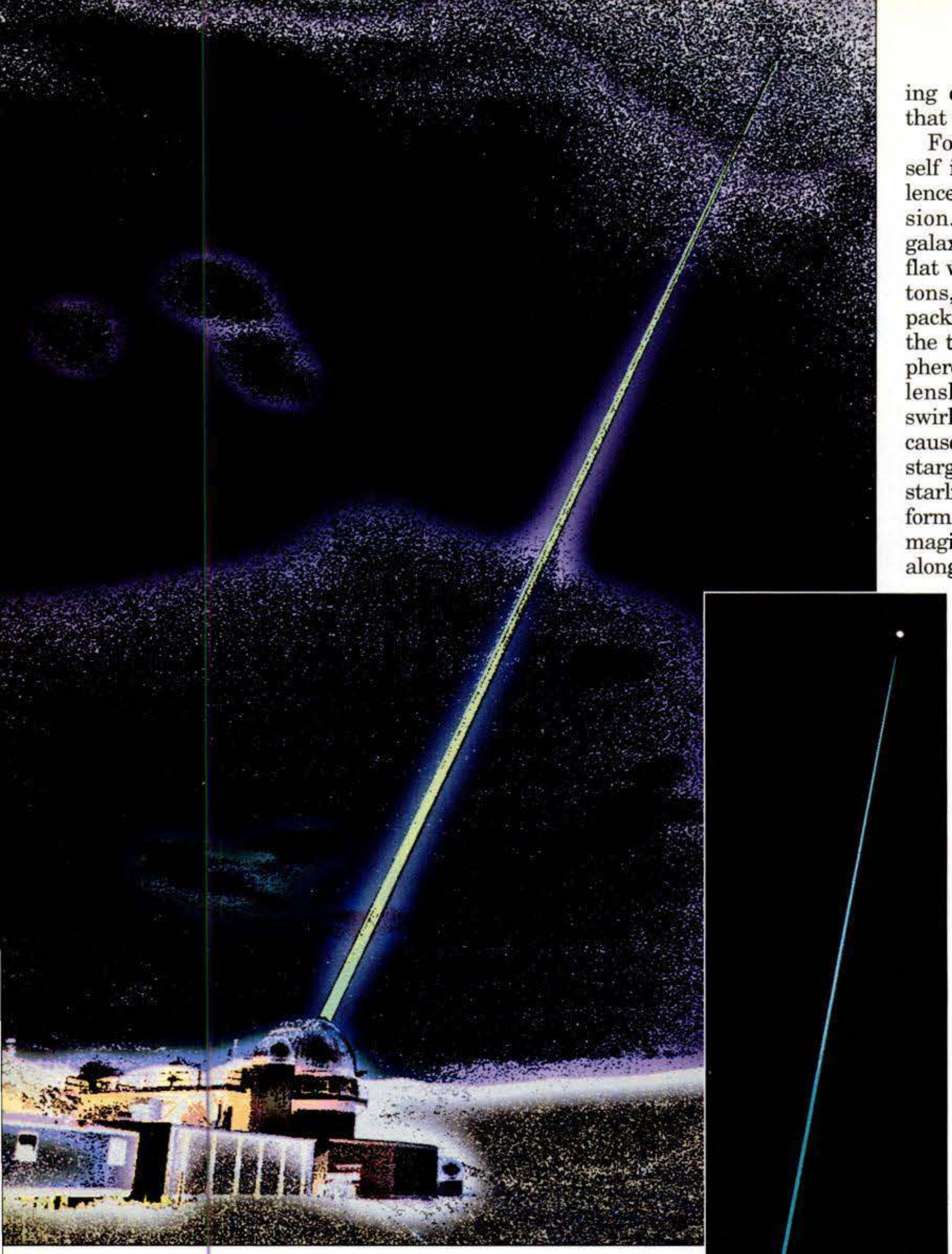

A green copper-vapor laser beam slices ten kilometers into the atmosphere (above) from the Starfire Optical Range. At its zenith (right), the beam focuses to create an artificial star called a laser guide star. By analyzing light returning from this guide star, scientists can "subtract" the distorting effects of Earth's turbulent atmosphere. The result: a clearer view of objects in the heavens.

olutionize civilian astronomy. Adaptive optics can spectacularly increase resolution, or the ability to see detail, by factors of 50 to 100.

In some ways, say many astronomers, images from Earthbound instruments with adaptive optics will even surpass those from the orbiting Hubble Space Telescope: Light-gathering mirrors for ground telescopes can be far larger than the 2.4-meter (95-inch) mirror on the Hubble, which had to fit aboard the space shuttle. (For observation using the shortest wavelengths of light, however, a space telescope will remain superior.) Adaptive optics is already being planned for the world's largest telescopes, including the ten-meter Keck on Hawaii's Mauna Kea.

Adaptive optics was originally proposed in 1953 in a paper by astronomer Horace Babcock; another two decades would pass before experiments began on the concept of using deformable mirrors. In the 1980s, the technology found new life as part of the "Star Wars" goal of getting beam weapons to hit incoming enemy missiles at full strength; that work was declassified in 1991.

For astronomers, the atmosphere itself is an enemy, a blanket of turbulence that robs telescopes of 20/20 vision. Light from a distant star or galaxy arrives at Earth as a uniformly flat wavefront—a neat package of photons, or particles of light. But that package is damaged merchandise by the time it travels through the atmosphere, because it is distorted by the lenslike effect of heated pockets of swirling air. It's the same effect that causes the twinkling you see when you stargaze. Adaptive optics restores the starlight wavefront to its original uniform shape in a process that, like some magic tricks, is done with mirrors—along with a generous assist from genuine electro-optical wizardry.

With its 3.5-meter (138-inch) mirror, Starfire's new $27 million telescope is built to monitor thousands of fast-moving low-Earth-orbit satellites. It can track and photograph objects that are as small as a basketball, traveling 1,000 miles above Earth. The telescope will have an adaptive-optics system installed in mid-1995; in the meantime, for test runs, it shares a laser from a 1.5-meter (60-inch) telescope at the site.

During a recent visit to Starfire, I drive around the narrow road leading up a hill, passing that 1.5-meter instrument on the way to the top. There, I see Starfire's 3.5-meter telescope, the largest in the Defense Department. The telescope's unique three-piece cylindrical enclosure, which resembles a giant collapsible Boy Scout camping cup, gleams yellow in the late afternoon sunlight.

"I can't talk long," Starfire director Robert Q. Fugate says tersely when we meet. "I've got a lot to do." It's the physicist's typical greeting: Fugate, probably the world's foremost authority on adaptive optics, is known as one of the busiest people in the Air Force. He has labored tirelessly, often 80 hours a week, for more than a decade to develop Starfire. Behind Fugate, in the telescope's control room, technicians preparing for the evening's observations attend banks of computer monitors. As we talk, Fugate compulsively glances at the computer screens.

We climb the stairway to the telescope deck as the sky begins to darken. The 35-foot circular shutter at the

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top of the telescope's enclosure opens, revealing the moon and a few stars and planets. Technicians soon begin retracting the aluminum walls of the enclosure. With a soft, whirring mechanical noise, the structure's eight supporting pillars smoothly descend almost 30 feet into towers in the building's foundation. The process takes less than two minutes.

"This is the only large telescope that operates in the open air," Fugate says (see "A Topless Telescope"). A traditional dome would have been too cumbersome for Starfire to track fast-moving satellites, he adds. And track it can: I've seen the massive, nearly 22-ton telescope swing to scan across the sky as fast as an Audubon member following a flying bird with binoculars.

Down the hill at the 1.5-meter telescope, a green laser searchlight shoots skyward, sending up 5,000 pulses of light per second. The beam tapers to a point ten kilometers (six miles) high, where a new "star" appears. This man-made beacon is called a laser guide star. The artificial star, created by atmospheric molecules sparkling in the heat of the copper-vapor laser beam, is the key to making adaptive optics work for astronomy. By positioning the guide star next to a celestial object (such as a star or galaxy), scientists can analyze its reflected laser light and determine precisely how to correct for atmospheric distortion. "As the light from that artificial star propagates back down, it picks up the atmosphere's wavefront distortion," adds Fugate.

Reflected light from the guide star is collected by the telescope's mirror and routed into a specialized camera called a wavefront sensor. The sensor measures the atmospheric distortion, taking samples 120,000 times a minute. A unique, highly parallel computer then processes the information and sends corrective commands to the second, deformable mirror. This saucer-sized "rubber" mirror, made of special glass, is about one millimeter thick. "The deformable mirror is small. We reimage the [1.5- or] 3.5-meter mirror onto the surface of the small mirror" to perform the image correction, says Fugate. He explains that "it would be difficult to build a mirror as large as 3.5 meters that could move rapidly enough to keep up with atmospheric changes."

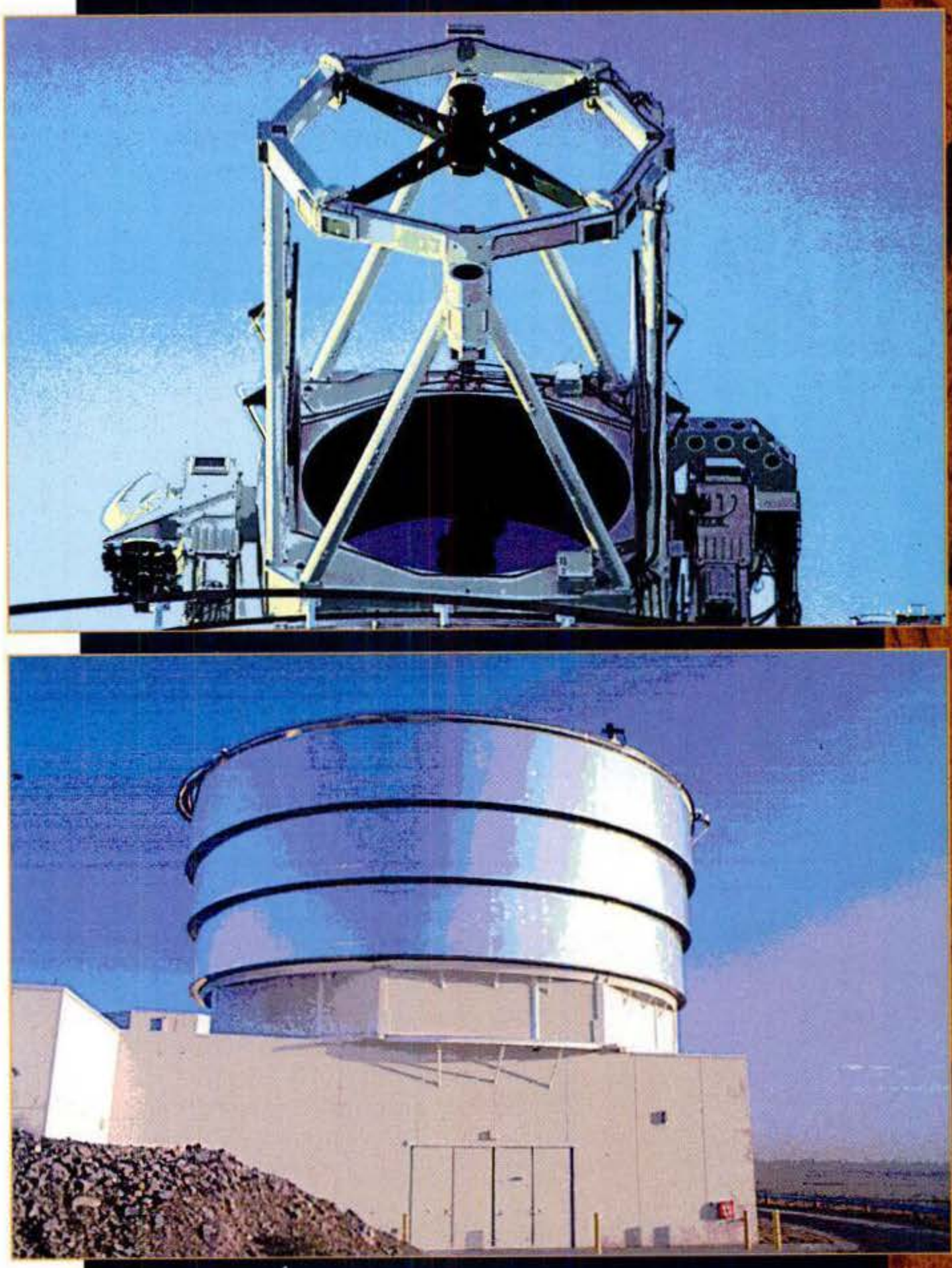
[*Continued on page 85*]

A TOPLESS TELESCOPE

A traditional observatory dome would only hinder the Air Force's fast-steering Starfire Optical Range telescope. So the telescope is a "convertible"—it has a unique three-piece aluminum-and-steel enclosure that retracts for open-air observation. Telescoping aluminum cylinders nine feet high and 70 feet in diameter are suspended from a circular roof structure by eight columns. For nightly observations, the columns lower into towers in the building's foundation. "We have an emergency procedure for raising the dome," says Starfire's director, Robert Q. Fugate. "It involves eight really strong people."

Eliminating a conventional dome also cuts heat buildup—a problem for telescopes, since even minute air-temperature inconsistencies can reduce image quality. Starfire is also outfitted with an elaborate heating and cooling system. Air circulates throughout the building, the telescope, and its mirror, to keep the device at exactly the temperature of outside air. "We actually monitor outside air temperature and predict what it will be in 30 minutes," adds Fugate. "That information is used to adjust the coolant temperature."

As an open-air telescope, Starfire is susceptible to wind buffeting, which shakes the sensitive instrument. Sensors mounted on the telescope structure send signals to a fast-steering mirror to cancel wind effects.—*R. N.*



The world's largest open-air telescope, an instrument with a 3.5-meter mirror at the Starfire Optical Range, has a unique collapsible enclosure (above). Nesting cylinders retract for nightly observations (top).

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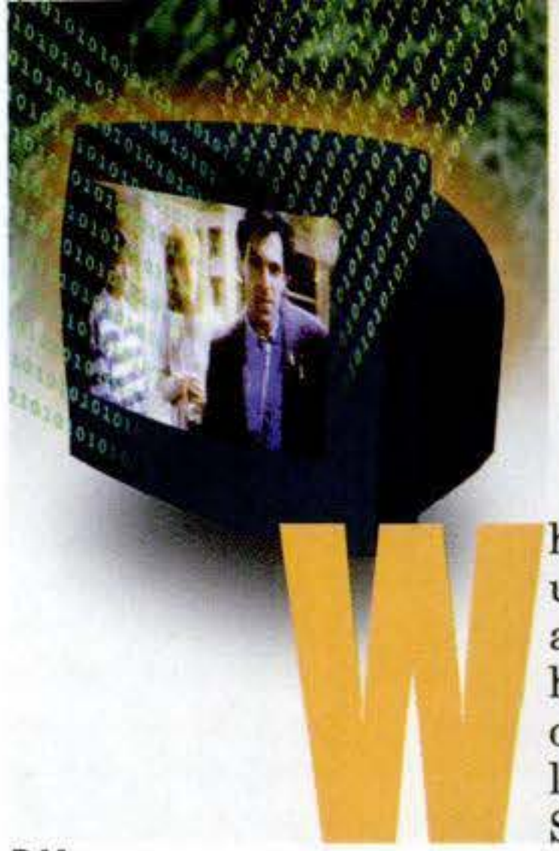

Little DISH TV

BY DAWN STOVER

When I moved from a suburb of New York City to a mountainous and heavily forested region of Washington state, I left television behind. Sure, I brought my TV set along in the U-Haul. But even with the help of a large antenna mounted on a 30-foot pole, I could tune in to only one or two channels (depending on weather conditions) in my log cabin tucked in the woods.

I couldn't watch a basketball game without seeing at least 20 ghostly players on the court, dribbling through a blizzard of snow, the color melting from their uniforms at frequent intervals. Sometimes the picture disappeared entirely, turning my television into a crackling excuse for a radio.

My TV and VCR became useless for anything but watching prerecorded videotapes. But to rent a movie and return it the next day required at least 90 minutes of driving. A few months ago, however, I finally found a solution to my television troubles. Two solutions, in fact.

The first arrived in a large box containing a VCR-size satellite receiver, a remote control, and a dish antenna only 18 inches in diameter. The RCA Digital Satellite System (DSS), made by Thomson Consumer Electronics and sold by electronics stores and satellite dealers throughout the lower 48 states, promised me access to up to 175 channels of cable programming, pay-per-view movies, and music.

But DSS isn't the only small-dish digital satellite system. PrimeStar Partners, a company that leases rather than sells satellite equipment to customers, offers a system that receives more than 70 channels. The PrimeStar antenna is larger than the DSS dish. But at 36 to 39 inches it is still much smaller than most satellite antennas. It is targeted primarily at households that don't have access to cable television.

I arranged to have the two systems installed at my home, so that I could see how they compare. The DSS unit, one of the first off the assembly line, arrived soon after programmers began broadcasting a live signal on June 17. The PrimeStar system was installed on August 1, the day that the company switched to digital service. Thus, I became one of the first people to try both systems. I was fortunate to have a southern exposure, which is necessary for these dishes to receive signals from satellites positioned above the equator. If my dishes' lines of sight had been blocked by trees, a mountain, or a taller building, I'd be out of luck.

Backyard satellite equipment has been around since the late 1970s, but most of the two million or so dishes now scattered across the countryside are C-band systems. These systems, which cost about $2,000, receive an analog signal using an antenna that is typically seven to ten feet in diameter. Cable television, now available to about 87 percent of U.S. households, is also an analog system.

As digital signals, the audio and video information of PrimeStar and DSS theoretically doesn't degrade during transmission. PrimeStar and DSS both claim picture quality equal to that of a laser disc player, and sound quality equal to that of a CD player.

Digital technology also enables engineers to squeeze more data onto the airwaves. PrimeStar was introduced four years ago as an analog system with only ten channels. But the recent switch to digital instantly increased channel capacity sevenfold. The company distributed new receivers to all of its customers so that they could decode the digital signals.

Both PrimeStar and DSS receive signals from satellites parked 22,300

JESSE DOQUILO

Tired of the tyranny of your local cable company? Here's the

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hands-on lowdown on the newest digital satellite receivers.

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JOHN B. CARNETT

Though the set-top boxes are similar in size, the PrimeStar dish dwarfs the RCA.

miles above Earth in geostationary orbit. But these birds are of two distinct species. PrimeStar relies on a commercial-grade satellite and is classified by the FCC as a Fixed Satellite Service. DSS, on the other hand, is a Broadcast Satellite Service.

There are significant differences between the two categories of service—differences that explain why the RCA dish is so much smaller than the PrimeStar dish. First, broadcast services are authorized to operate at higher power than fixed services. The twin satellites that beam signals to DSS dishes can operate at 120 watts, while the lone PrimeStar satellite operates at only about 45 watts. The higher the power of the satellite, the smaller the size of the antenna needed to receive signals from it.

Also, broadcast satellites are spaced nine degrees apart in the sky, while fixed satellites are separated by only two degrees. Antennas receiving signals from the more widely spaced satellites can be smaller because they are less likely to suffer from interference problems.

"These two types of satellites represent different philosophies," says Steve Blum, consumer marketing manager of United States Satellite Broadcasting (USSB), one of three companies that helped create the DSS system. "The commercial-grade satellites are as simple as possible, and the equipment on the ground is complicated. But with direct-broadcast satellites, you're making it complicated in orbit so you can use simple equipment on the ground." More than half of the $1 billion spent to develop the DSS system went toward building and launching the satellites themselves, Blum says.

To subscribe to DSS services, you first have to buy the necessary hardware. A basic model costs $699. The $899 step-up model has a dual-output dish that allows you to connect it to more than one TV. And if you want to watch more than one channel at a time, you'll need to spend $649 on a second receiver.

The DSS installation is relatively easy. A local satellite dealer, working alone, finished mine in about two hours. He mounted the antenna on a bracket screwed to the south side of my house and then used a tone generated by the receiver to point the dish: The tone gets louder as the signal gets stronger. The rest of the job was easy—just a matter of laying cable and hooking up the receiver/decoder unit. A professional DSS installation costs $150 to $200. Alternatively, customers can buy a $70 self-installation kit that includes an instructional videotape and all the cables needed to put the system together.

Fewer than 1,000 PrimeStar subscribers have purchased their own equipment, at a cost of around $900. Most simply pay about $8 a month to lease it from the company, which is responsible for installing and maintaining it. Because my local cable company is not one of the six cable giants that collectively own PrimeStar, the two men who installed my system had to drive more than 150 miles to reach my house. It then took them about four hours to erect the antenna (mounted on a ten-foot pole sunk in concrete), aim it properly, attach the necessary cables, connect the receiver to a phone line, and test the whole setup. The average installation costs about $200.

Professional installation is required for PrimeStar because its antenna uses linear polarization. In this type of polarization, the vertical and horizontal positioning of the antenna must be precisely aligned, like crosshairs in a rifle scope. The DSS dish, on the other hand, uses circular polarization—a technology that is less efficient but more forgiving. "We tried to make it as simple as possible for the customer to point the dish," explains Michael D. O'Hara, general manager for the DSS product at Thomson.

With my new dishes in place, I started ordering programming. Two independent companies sell programming to DSS dish owners. The bulk of the channels belong to DirecTv, a unit of GM Hughes Electronics. DirecTv owns 27 of the 32 satellite transponders that transmit signals to DSS receivers. For $21.95 a month, the company offers a basic package of more than 30 channels, such as ESPN and CNN. DirecTv also throws in about 30 music channels and more than 50 pay-per-view movie channels. A package of regional sports programming costs $7.95.

The remaining five satellite transponders are owned by USSB, a subsidiary of Hubbard Broadcasting. USSB offers a $7.95 "essentials" package that includes Lifetime, Nickelodeon, MTV, VH-1, Comedy Central, and the All News Channel. The company also offers packages of five HBO channels or three Showtime channels for $10.95 a month. And for $34.95, you can buy the "essentials" plus all the premium movie channels, including three Cinemax channels, two versions of The Movie Channel, and Flix. The first month of programming from USSB is free.

To get premium movie channels as well as basic channels and pay-per-view movies, DSS owners will need to order from both companies. That means two telephone calls to set up the system, and two bills every month.

With PrimeStar, there is only one source for ordering and billing. For $21.95, I ordered PrimeStar's basic package, which includes a dozen or so cable channels such as CNN and Disney, six music channels, 11 pay-per-view channels, and 13 regional sports channels. For an additional $15.95, I ordered three HBO channels and two

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Cinemax channels. Noticeably missing from the PrimeStar lineup are Showtime, The Movie Channel, Nickelodeon, MTV, and other programming produced by Viacom. PrimeStar is still negotiating for those channels, which may be available by the time you read this.

The sound quality for both systems is excellent. The manufacturers aren't exaggerating when they make the comparison with CDs. The picture quality offered by the two systems, except for an occasional glitch on the RCA system, is equivalent. Both systems deliver video that is generally superior to off-the-air broadcasts and cable reception, although it may be stretching the truth a bit to call it laser disc quality.

Cable subscribers typically spend about $31 a month on programming. The prices charged by PrimeStar, DirecTv, and USSB are roughly equivalent to cable fees, but, generally, subscribers to the new satellite systems receive more channels.

Both PrimeStar and DirecTv allow subscribers to order network programming only if they live in "white areas" that are not served by local TV stations, and they have not subscribed to cable services within the last 90 days. Access to all five networks (ABC, CBS, NBC, PBS, and Fox) costs $3.95 from DirecTv, or $3.95 to $5.95 a month from PrimeStar. This can be a real service in places like Arietta, N.Y., a town that is four miles from the nearest cable system, and whose 301 residents are unable to receive more than two channels off the air. PrimeStar christened Arietta its first "digital town" a few months ago, installing receivers in more than 80 households.

More than 100,000 households currently subscribe to PrimeStar. DirecTv and USSB have not released figures for their subscribers, but Thomson announced a manufacturing goal for DSS: The company planned to build 600,000 units by the end of 1994.

Built into the DSS system is an on-screen program guide. The guide is interactive: To select a channel, you use arrow keys on the remote control to move a highlight bar to the program you want to view, and then press the select button to display the program. You can also call up a screen that provides information about the program selected. Other menus allow you to look at one category of programming at a time, such as movies or sports. And within those categories, you can narrow your selections further—to comedies or football, for example.

DirecTv and USSB do not provide printed guides with subscriptions. That's unfortunate, because you can scan a printed page much more quickly than the electronic guide, which only displays five channels at a time. Three companies do sell TV guides for the DSS system, however.

PrimeStar's printed guide comes free with a subscription, but its electronic guide is a disappointment. It displays upcoming programs on a scrolling screen like the ones used by many cable companies. If you want to see what's on every channel, you have to wait for the guide to go through a complete cycle. Also, the guide displays listings in Eastern time, so if you live elsewhere in the country, you have to compute the time difference. The company says it is negotiating for rights to an interactive guide, which will be introduced sometime this year and will work with the existing remote control.

Unlike the PrimeStar system, the DSS can be purchased with a universal remote control that operates the TV and VCR as well as the satellite receiver. That makes the DSS receiver more convenient to oper-

DUELING DISHES

PRIMESTAR		DSS
36 to 39 inches	Antenna size	18 inches
17"x13"x3.25"	Receiver/ decoder size	15"x11"x3"
77	Number of channels	175
Approximately $900, or $8/month lease fee	Hardware cost	$699 (basic model),$899 (step-up model for multiple TV hookups),$649 (additional receiver for watching two channels simultaneously)
Primarily through cable companies	Where to obtain hardware	Consumer electronics chains, satellite equipment dealers
$199.95 on average	Installation cost	$69.95 for self-install kit; $149.95-$199.95 for dealer installation
Approximately $21.95-$54.95 (set by distributors)	Subscription cost for cable programming	$5.95-$29.95 (DirecTv), $7.95-$34.95 (USSB)
$3.95	Pay-per-view movie cost	$2.99 ($2.49 coupon for one movie each month)
More than 100,000	Number of subscribers	Not available, but Thomson's goal was to manufacture 600,000 units in 1994
One medium-power (45-watt) Satcom K-1 satellite	Satellite(s)	Two high-power (120-watt) GM Hughes HS601 satellites
DigiCipher II technology from General Instrument; upgrading to MPEG-2 by end of 1995	Digital data compression	MPEG technology from Thomson Consumer Electronics and GM Hughes; upgrading to MPEG-2 in early 1995
Non-interactive scrolling on-screen guide, monthly printed guide free with subscription	Programming guides	"Point and select" interactive on-screen guide; printed guide sold separately for $4.95
User can program one list with any number of channels	Favorite channel lists	User can program two lists of ten channels each
User can select channels to be locked out, or set ratings limit	Programmable lockouts	User can select channels to be locked out, set ratings limit, or set pay-per-view spending limit

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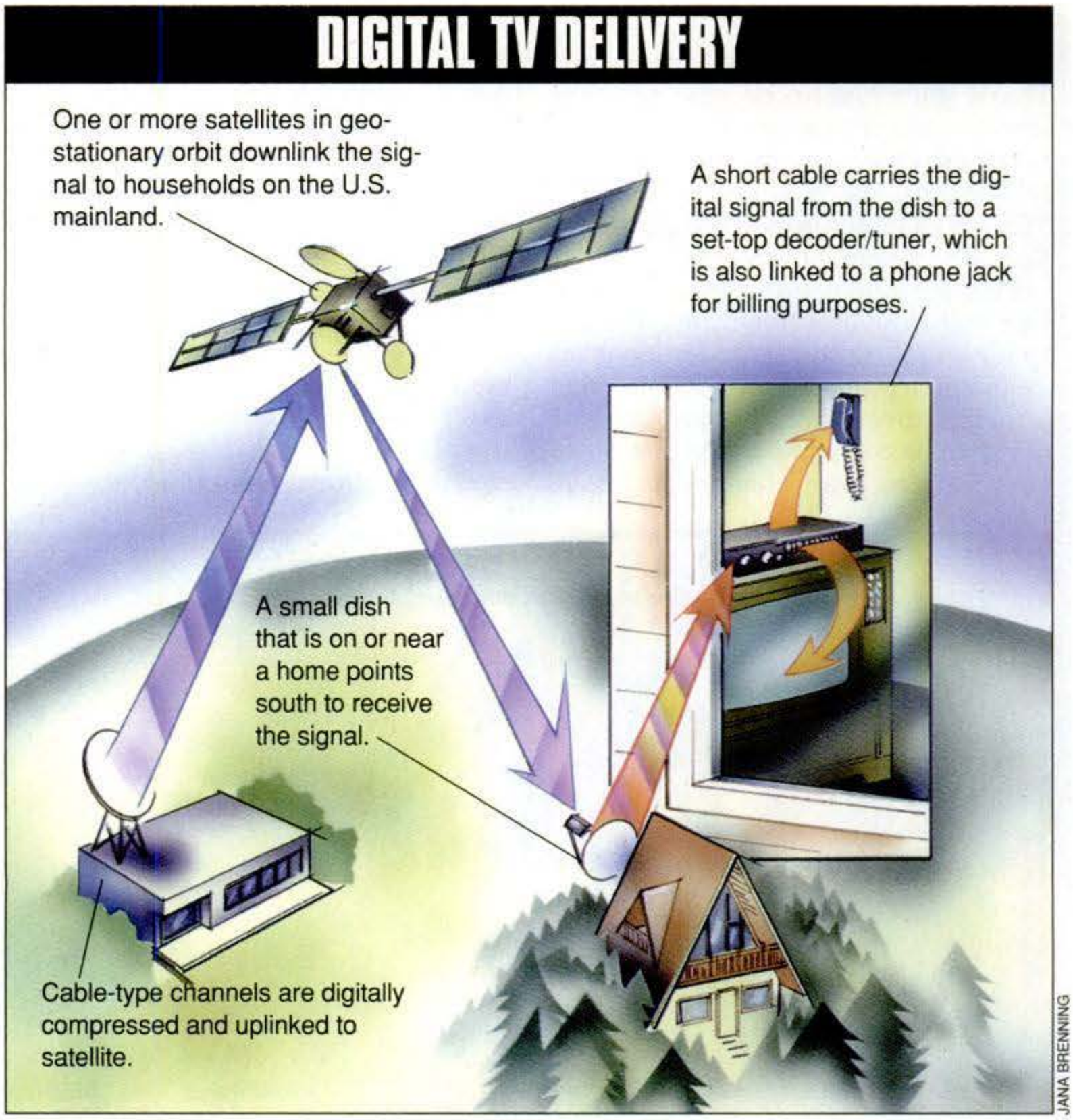

ate and reduces coffee-table clutter.

Both systems allow you to purchase pay-per-view movies without getting up. You simply call up the channel on which the movie is playing and press a few buttons on the remote to buy the flick. The receiver, which is wired to a phone jack, later places a toll-free call to a central billing station to record your purchase, which shows up on your monthly statement. DirecTv charges $2.99 for movies and sends subscribers a $2.49 coupon toward one movie each month. PrimeStar charges $3.95 per movie. PrimeStar installers usually put in a dedicated phone jack for the satellite receiver. DSS owners wire their receivers to existing phone jacks or purchase a phone-jack accessory that plugs into an AC outlet.

Like pay-per-view movies on cable, the viewer is required to tune in at a specific time. DirecTv offers many of its hit movies every 30 minutes. But even with closely staggered movies, pay-per-view services are not as appealing as true "video-on-demand," a service proposed by some telephone and cable companies that would allow customers to order movies instantaneously from a large library.

DSS and PrimeStar do give you some opportunities for personal control, however. Both systems let you edit the list of channels that are displayed when you turn on the receiver. DSS also lets you create two favorite-channel lists, with up to ten channels each. You then press a button on the remote to switch between lists.

Both systems also allow you to restrict viewing access. To prevent children from watching certain channels, you can select a password that controls entry to those channels. You can also set ratings limits; ratings information is embedded in the satellite signal for most movies, and the password is required to watch a show with a higher rating than the limit.

Other special features include an alternate audio button on the DSS unit, which allows you to switch between languages on bilingual stations. A special feature on the PrimeStar unit is a sleep timer that lets you program the system to turn off after a specified time period.

Despite their sophistication, both the PrimeStar and DSS systems suffer from several major shortcomings. The biggest problem is that neither system provides access to local programming. To get this, you need to pair your satellite dish with an off-air antenna or pay for basic cable, assuming it's available. If you've already made unsuccessful attempts to get a good off-air signal, you may never be able to watch the local evening news.

Depending on where you live, you may also have trouble catching the network news on the satellite. Because most programs are broadcast on an Eastern time schedule, the evening news is televised at 3:00 p.m. on the West Coast. The good news for us is that we don't have to stay up late to watch David Letterman.

Another problem is rain fade: Severe storms can temporarily block the signal from the satellite. "All high-frequency signals in the Ku-band are subject to rain fade, including DSS and PrimeStar," says O'Hara. "If the system is properly installed, the picture will probably be affected only by very heavy rain—enough rain to make you pull over in your car." Heavy snow can have the same effect.

Thomson says that rain fade is a problem for the DSS system only 0.3 percent of the time. That means that if you watched DSS 24 hours a day for an entire year, you'd lose about one day of viewing time. It's not a lot, but it could be a major aggravation if the picture disappears in the middle of a movie or an important game. DirecTv says it will compensate customers for any purchased programs that are interrupted.

PrimeStar claims that because its dish is larger, rain fade is a problem only 0.1 percent of the time. "We don't believe in a one-size-fits-all approach," says Jeff Smith, vice president of marketing and programming. "Our approach is to fit the dish size to the location."

PrimeStar says its larger dish also makes the system less susceptible to the momentary freezes and other transmission glitches that I observed on the DSS system in the first few weeks after its introduction. The glitches occur when digital data is compressed too tightly. The standard TV signal contains 30 video frames a second. But with the Motion Picture Expert Group (MPEG) data-compression technology used for DSS systems, the video signal is reduced to eight frames a second. When the picture changes rapidly—for example, during a basketball game or a play in a football game—the MPEG compression system can't always keep up. The result: Random blocks of color and freezes in the picture can momentarily appear on-screen.

The number of glitches has dwindled, and Thomson maintains that they will disappear entirely with software improvements. Within the next few months, DSS programmers will switch to a new data-compression standard called MPEG-2. DSS re-

[Continued on page 84]

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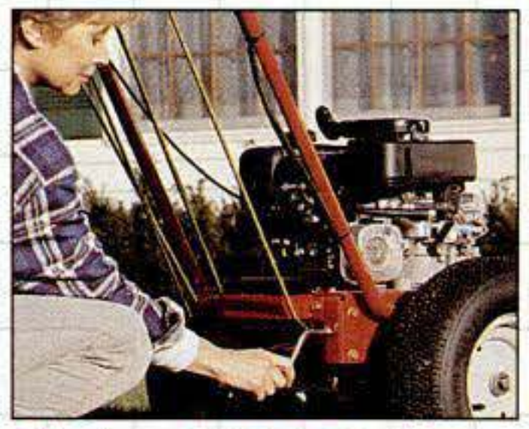

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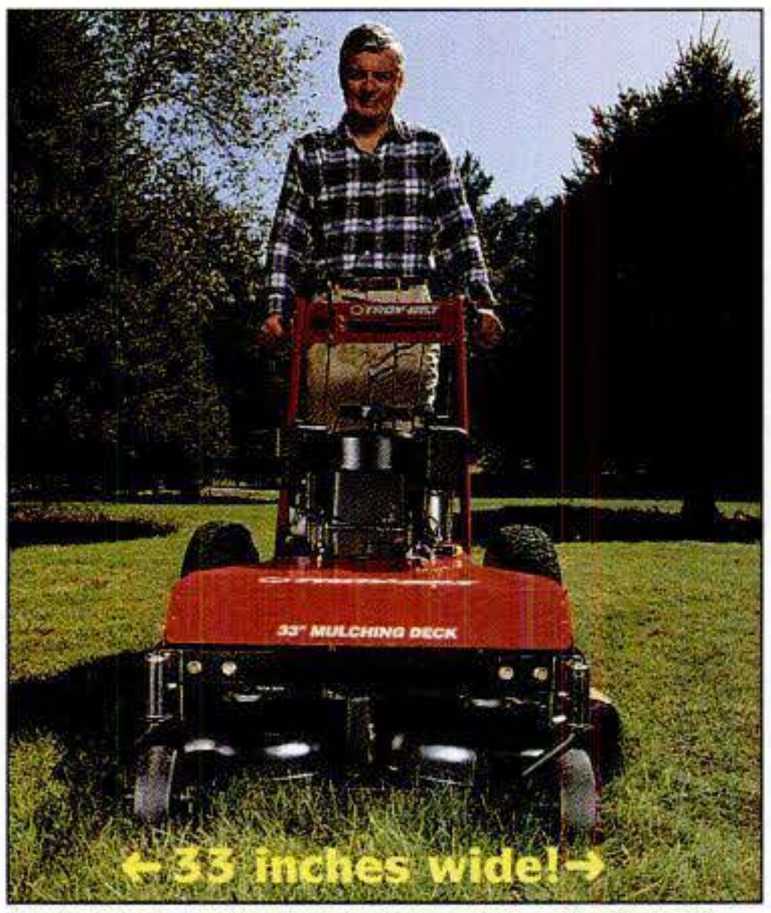

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BY ARTHUR FISHER

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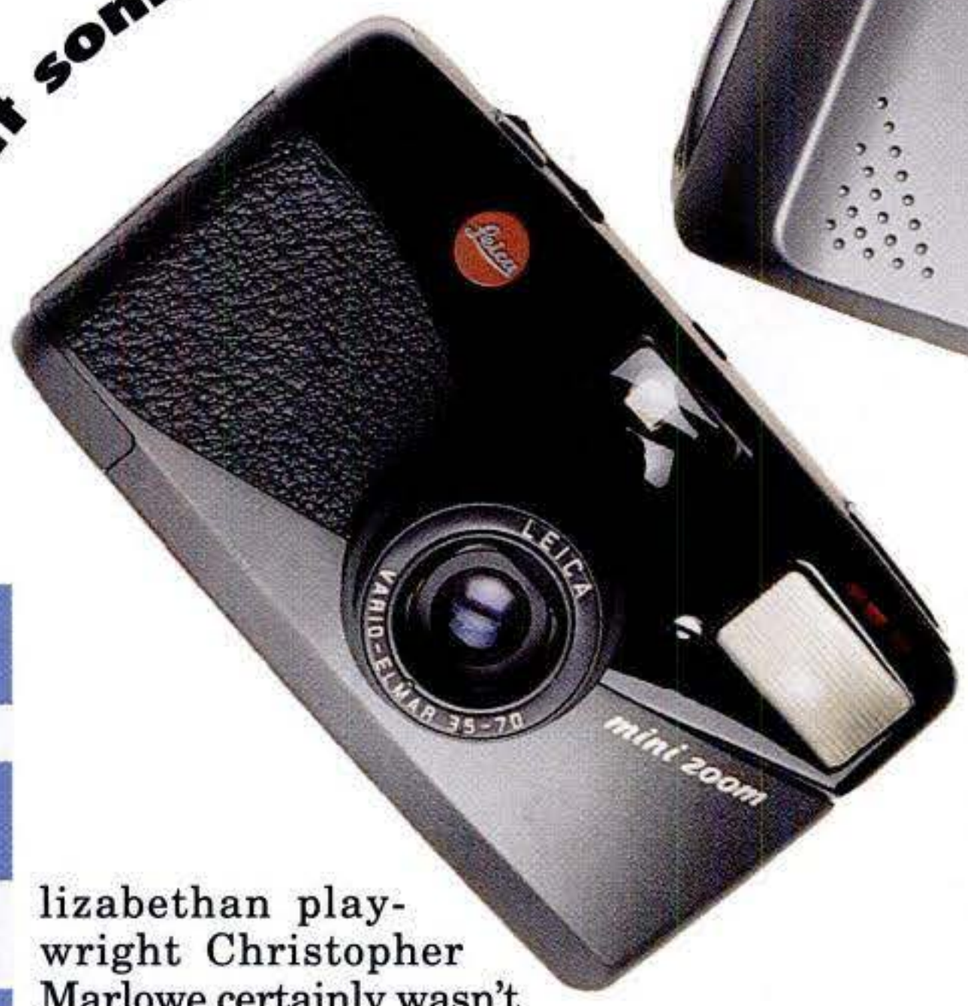

A quintet of compact zoom 35mm cameras, from left to right: Contax T VS, $1,695; Nikon Lite-Touch Zoom, $240; Leica Mini Zoom, $415; Rollei Prego Zoom AF, $375; and Olympus Infinity Stylus Zoom, $325.

Elizabethan playwright Christopher Marlowe certainly wasn't thinking cameras when he wrote of "infinite riches in a little room," but the description fits this new generation of nifty point-and-shoots. Call them Baby Zoomers: These lightweights can fit into a shirt pocket, but pack heavy artillery—sophisticated zoom lenses. The combination makes them a natural for travelers and as second cameras for devoted SLR users. Some have features (and prices) that would have been unthinkable in cameras this size not long ago.

Take the Contax T VS. Its superb 2X zoom lens is a Carl Zeiss T* Vario-Sonnar that ranges from 28mm to 56mm. It's made of high-strength precious materials: a super-slick titanium body, a sapphire glass viewfinder, and even—hold onto your hat—a recrystallized sapphire shutter button. It has three highly unusual features not found in more plebeian point-and-shoots.

First, the Contax permits manual focusing to supplement the autofocus system, which can get as close to the subject as 1.7 feet. Second, the photographer can choose not only standard programmed auto exposure (in which the camera selects the aperture/shutter-speed combination), but also an aperture-priority exposure mode: You set the aperture, the camera figures out the appropriate shutter speed for the light level of the scene. Third, the lens is not powered, but is zoomed manually by rotating a ring, a method preferred by many photographers because it permits precise framing.

Of course there's a built-in electronic flash with pre-flash red-eye reduction, but you can also mount an external flash with an optional adaptor. Did I mention panorama mode? It's in there too, selectable by moving a lever, even in mid-roll. Self-timer? Bulb shutter-speed for time exposures? Sure.

You get all this in a package just $4^{13}/_{16}$ inches wide by $2^{9}/_{16}$ inches high by $1^{1}/_{2}$ inches deep, weighing 12.3 ounces. You get it, that is, if you ante up $1,695, the suggested list price.

The surprising thing is that you can get many of these features—zoom lens, total automation, and all—in equally small or even smaller packages for a good deal less money.

The Rollei Prego Zoom AF, for example, sports a Schneider-Kreuznach 35-70mm powered zoom lens. It uses fuzzy logic to control exposure, focal length, the five-function flash with red-eye reduction, and its active infrared autofocus system that uses 256 zones. Add such niceties as a variable timer for a sequence of shots, a three-step zoom mode that takes three consecutive exposures at three different focal lengths, and a self-timer with three different options. Pressing an unusual button marked "Snap" automatically moves the lens to wide-angle position and sets the camera to focus on a range of about four feet to 17 feet, ideal for "snapping" active children and animals. Holding the shutter button down produces a series of exposures. The $375 Prego is compact and, at just 8.5 ounces, lighter than the Contax T VS.

The Olympus Infinity Stylus Zoom boasts svelte, curvaceous styling with its unique clamshell lens cover-up design. These sensational looks made the original non-zoom

[*Continued on page 87*]

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Have you ever wondered what your next-generatio

he way technology will play a role in our daily lives in the years ahead has many variations. But it is certain that a communications revolution already underway will have the broadest effect of all. If history is any judge, we know this from simply observing the remarkable evolution of the telephone.

Peering ahead with the specific charge to design and build the next generation of tools capable of making us participants in this communications revolution is Carl S. Ledbetter, president of AT&T's Consumer Products Division. He's the person responsible for moving gadgets out of the laboratory and into the home. As such, the 44-year old mathematician is in charge of the development of some of the most common—as well as the most advanced—communications devices of our time. Recently, in an interview with POPULAR SCIENCE's Editor-in-Chief Fred Abatemarco and Electronics Editor Michael Antonoff, Ledbetter described some of the new communications products and concepts that AT&T is planning to introduce in the near future.

THE FUTURE IS NOW

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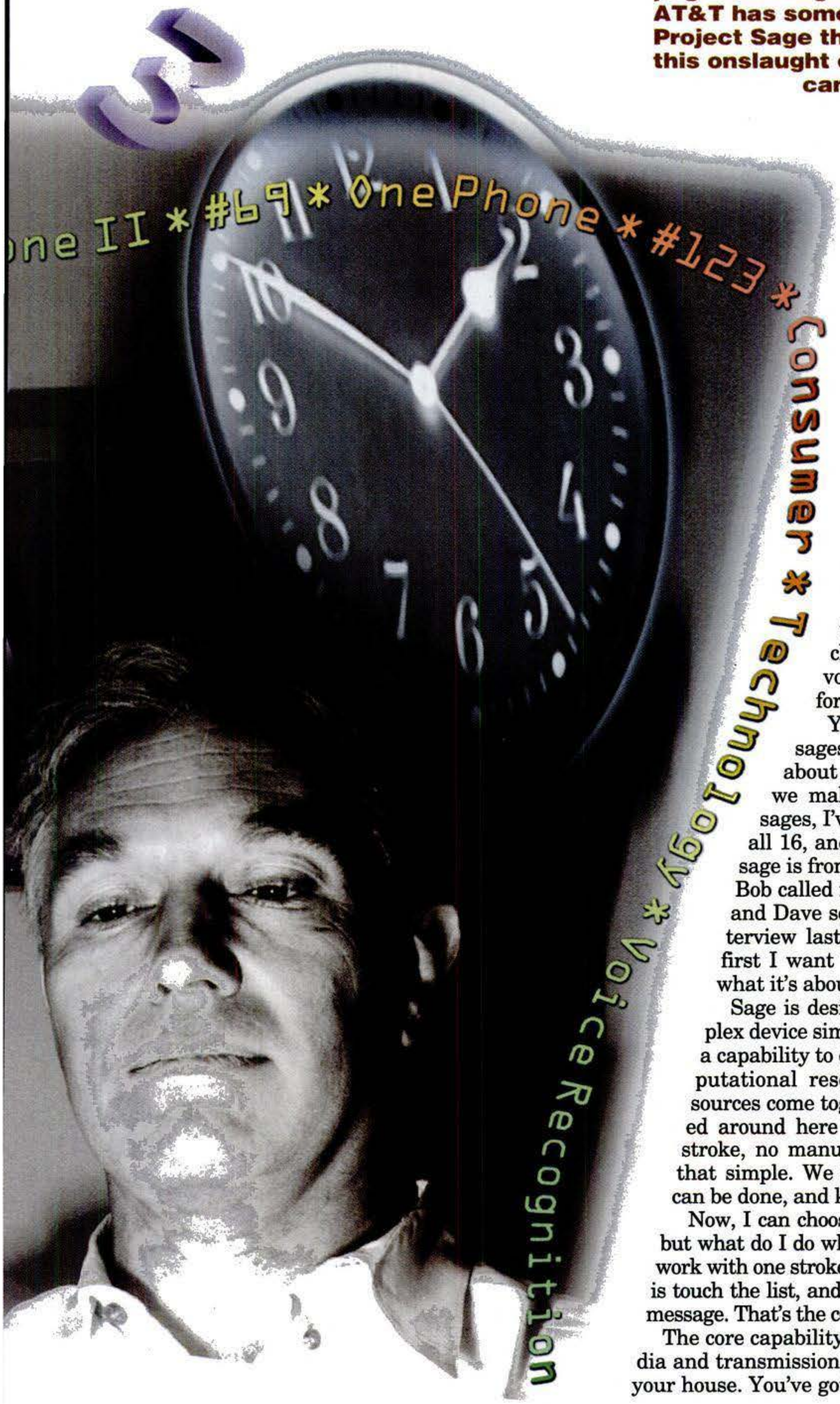


People are inundated with phone calls, voice messages, faxes, e-mail, even pager messages. We understand that AT&T has something under wraps called Project Sage that is supposed to make this onslaught easier to manage. What can you tell us about it?

Sage is a family of products that is well under development. The first two products will be available during the first quarter of this year. I'll give you a little sense of our direction. You probably get four kinds of messages routinely: telephone calls, recorded messages, faxes, and e-mail. And you probably get pager messages as well. They come over different kinds of networks: wireless networks, computer networks, telephone networks. What you'd love to do, I'm sure, is pick a device out of your pocket, look at it, and say, "Who do I have messages from? Oh, I have two faxes, three e-mails, four voice mails." One of the Sage concepts is the idea of a universal mailbox—regardless of the type of message sent to you. The device figures out the mechanics, whether it is a fax, an e-mail, a voice mail, whatever, it just handles it for you.

You also want to know who the messages are from. One of the things I hate about answering machines—even though we make them—is that if I have 16 messages, I've got to push the button and listen to all 16, and usually find out that the 15th message is from my boss. I'd really rather know that Bob called me at 3 o'clock, and he sent me a fax, and Dave sent me a fax on a briefing for this interview last night at 11 o'clock. Whatever it is, first I want to see what it is, who it's from, and what it's about.

Sage is designed to make a technologically complex device simple to use; to present to the consumer a capability to do work in an easy way in which computational resources and telecommunications resources come together. We have an axiom we've posted around here in the development laboratory: one stroke, no manual. Everything we do is going to be that simple. We look at something, see exactly what can be done, and know exactly how to do it.

Now, I can choose from a list of all kinds of messages, but what do I do when I see the list? Since things have to work with one stroke and no manual, the logical thing to do is touch the list, and it's going to show or play or print the message. That's the concept of Sage-type devices.

The core capability is connection to all the different media and transmission methods that bring information into your house. You've got a phone line. A wireless connection.

PHOTO BY JOHN B. CARNETT; PHOTO ILLUSTRATION BY TOM WHITE

Cable. Perhaps direct-broadcast satellite. Power lines. Why don't they all go to the same place so you can make decisions about how you receive and distribute messages? You might be watching TV and the phone rings. Why can't you have someone put a little piece of software in the TV that shows you who the call is from? Caller ID tells you right now. You can decide whether you want your Sage device to answer the phone or whether you want to accept the call.

With this ubiquity of connections to various networks and the ability to handle different message types, you can imagine the different services that you will be able to tie into directly once you have the core capability.

How close are you to fully achieving this idea of one stroke, no manual?

I would never say we're 100 percent. This is one of our key themes. As it turns out, you can't actually get to 100 percent because there are idiosyncrasies in the way people perceive things—somebody will like it one way and somebody else will like another. But we're moving the idea to where almost anybody can use a very sophisticated technology.

You have another project underway called Touchtone II. What can you tell us about that?

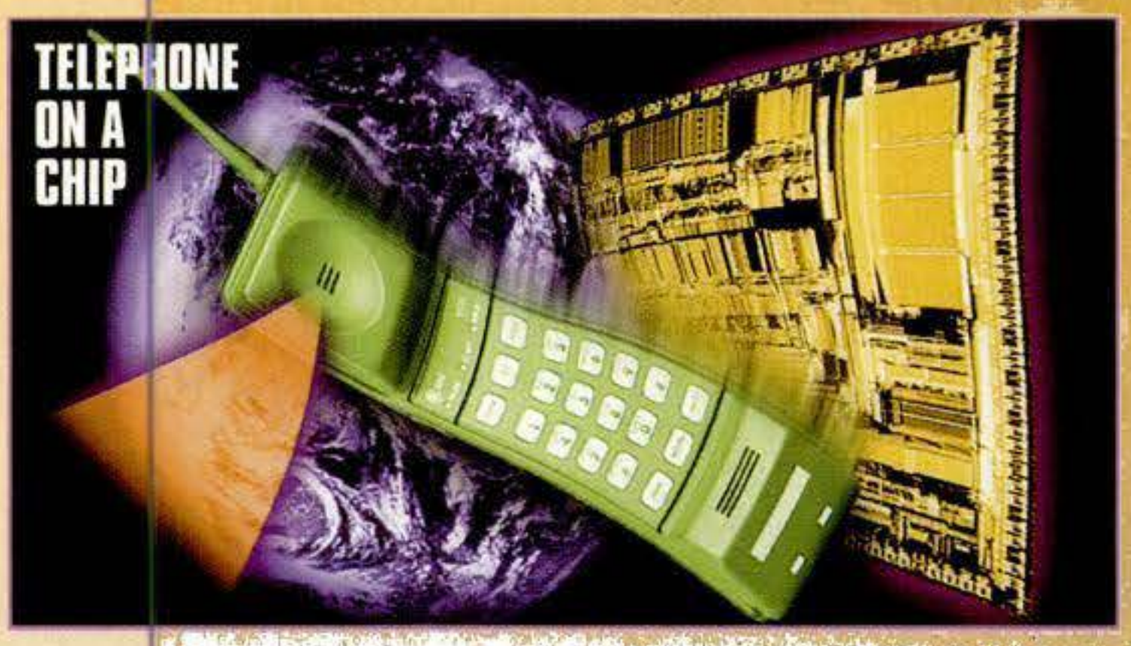
The issue is: What more do you need to make the next generation of the Touchtone pad more valuable to the consumer? It's intriguing that the global telephone network is unquestionably the single most complex piece of technology every deployed in the history of the world. Yet, literally anyone can manage it with a Touchtone pad. The Touchtone II project is about what the next generation of that interface will look like; we're not finished with it yet. We have the challenge of designing this interface so that it can handle more complex communications without becoming unmanageable—you can add too much.

I remember once trying to make a call using a phone pad on the back of an airplane seat. The pad was laid out four-by-three instead of three-by-four. The eight was on the far right-hand side of the second row instead of the middle of the third row. I almost couldn't make myself do it. The standard Touchtone layout was almost hard-wired in me, innately programmed.

I often ask people: Where is the "clear" key on your cellular phone? It's in a different place on every phone. We make a number of models here in my own business unit, and there are at least six different places where the clear key is located. So, what are we doing here? We're making it more complicated. And when you try to find the "clear" key on the phone while you're driving, that's a bad, bad problem. So, we're starting to map that out.

Also, we're starting to figure out that we need to be able to send text messages. Well, where are the Q and the Z? There are about three different places you can put the Q and the Z. Maybe you need some kind of an alphabet pad. There are also a lot of things you do routinely. People speed-dial, and every phone has the button in a different place. Phones have different numbers and different configurations. Some phones have 911 hard-wired, the rest have to be programmed, and when you have to program them, it's awkward. My wife complains that when somebody calls and gives a number, I have to program it into my phone.

A SAMPLING FROM THE COMMUNICATIONS REVOLUTION



The world is divided into more than 70 telecommunications standards that cover everything from differences in the timing of pulses on a rotary phone to how long phones ring. Until recently, AT&T had to replicate its development efforts for each country to accommodate these variations. But now, the company is introducing what it calls a "one-chip engine" in which specifications are programmed into the chip at the last stage of manufacturing with software that tells the chip what kind of telephone it's going into and what country it will be used in. By having a common technology platform, AT&T is able to reduce development costs. This also produces a faster turnaround time between concept and shipment and accelerates the introduction of more advanced models. The benefits for the public are lower prices and a greater choice of features. The project is code-named "Molly Whuppie" from a Spanish fairy tale character. The first chips are done, and AT&T will be deploying the first such phones in the United States.

Imagine coming home and finding on your TV screen a list of people who have sent you messages of various types: voice mail from Dad, e-mail from the bank, a fax from your secretary. Then, you could listen to or view the messages through the same set. Expect to see such a phone that connects to a TV by this spring. It will be one of two devices that will inaugurate AT&T's new line of screen-connectable intelligent phones, code-named Sage. The other will have a built-in screen. Later, there will be a phone that displays through a computer monitor. The products will be priced between $100 and $400. The phones will take advantage of caller ID, home banking, and other on-line services. You'll be able to receive personalized information, such as a daily report on how your stocks and mutual funds are doing; scores from particular sporting events; or localized highway traffic reports. Sage devices will contain a microprocessor and memory. And you'll be able to view a fax on-screen without needing to have a fax machine or fax modem.

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Why can't I just push a button and, say, capture that number? All of those ideas are part of the next generation that we ought to have in the interface for telephony, and for telecommunications and computational devices together.

Will there come a point in time when we'll see a transition away from what we now know as the Touchtone layout?

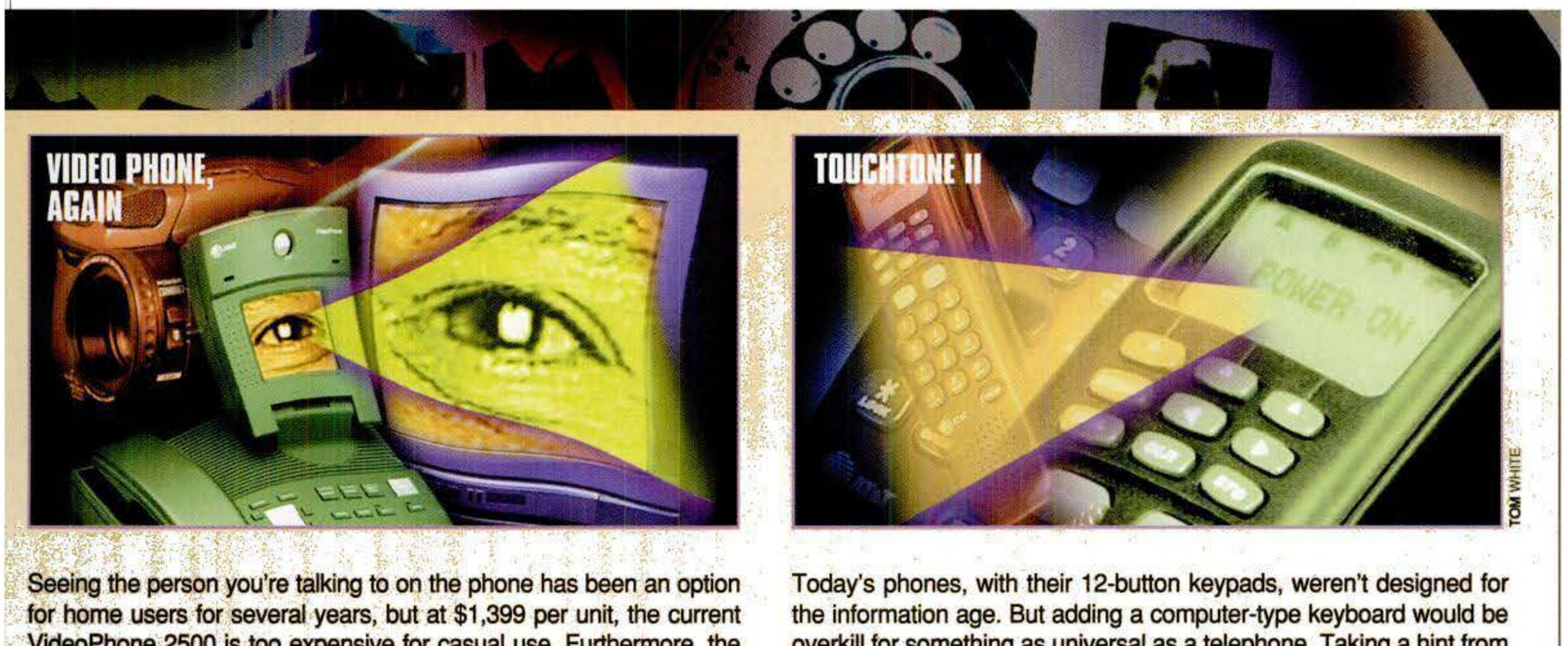
Just as we haven't completely abandoned the dial standard, we won't ever abandon the standard Touchtone layout for the entry-level phone. It's taken us a very long time to completely shift over from pulse to tone dialing on the network anyway, and there are some phones we still make on which you set the switch for pulse or tone. So, you're not going to see the abandonment of the Touchtone dial.

What you will see is a new generation of product that will begin to carry an additional format for the interface, and that format will invariably include some kind of a screen-based device to show you things. One of the key things we've learned really comes from automatic teller machines. [See "Touchtone II."] There are only three or four buttons alongside the screen. These buttons don't say anything. As the screen changes, and as the application you're using changes, an arrow points to the key and says this is what the key does now. You don't need a manual. You can walk up to the machine and everything you do is one stroke. You put your card in. You touch the buttons because the arrows tell you what they do. That's the kind of capability we want from the next-generation Touchtone pad.

You've also made reference in the past to a project called One Phone, the idea of having one telephone number that can follow you anywhere. How would it work?

As someone who has something like 17 different phone numbers, this idea appeals to me personally. The technological capability to do it exists today. There are business problems and other things that we need to deal with, but we can do it. There are several related issues. One thing that the Sage device could do is act as a switch. It knows where you are, and knows which physical mechanism is the one to be used to get to you at a particular time. Sage could be the traffic cop. We also have offerings in the market today that are moving in that direction, such as the 700 number. My parents have my 700 number. That number follows me wherever I go. It does not lock to a physical device. It's moving a switch, but you have to tell the network; it's a programming issue. I envision a day when you won't have to call somebody in the telephone company office and tell them to do it. You just do something on a telephone or other device that's part of our apparatus and it does it for you.

To a certain extent you can do that today with call forwarding, but it has limited capability now. There will be a day when if you have a cellular phone in your car and you pull into your garage, the network knows that you're in your house, and won't charge you cellular rates for a call you could be making on a land line. Why should it make any difference whether you're on the cellular handset or the handset that's connected to the wall phone that's wired in the kitchen? It really shouldn't, and eventually the industry will adapt this point of view. And, by the way, the handoff ought to be automatic, it ought to happen when



TOM WHITE

Seeing the person you're talking to on the phone has been an option for home users for several years, but at $1,399 per unit, the current VideoPhone 2500 is too expensive for casual use. Furthermore, the picture doesn't approach the clarity or frame rate of what you're accustomed to from television. Borrowing technology from its more expensive cousin, the AT&T Picasso [Best of What's New, '93], the next-generation VideoPhone will enable you to send still images. Each color image will be much more detailed than what can be seen in the motion frames transmitted by the 2500. Video In/Out ports will be added so you can use either a more flexible video camera than the fixed lens included or a freeze frame from a videotape; images will be viewable on a TV monitor or the built-in three-inch screen. Even though the AT&T Consumer Products Division plans to introduce the unit, a representative admitted that a realtor is more likely to buy one than a homemaker. Don't expect true lip-synch or a price reduction on the model when it becomes available in about a year.

Today's phones, with their 12-button keypads, weren't designed for the information age. But adding a computer-type keyboard would be overkill for something as universal as a telephone. Taking a hint from bank automatic teller machines, AT&T has begun putting three unlabeled or "soft" buttons on some of its new cellular phones. The purpose of the buttons varies according to text that appears on an adjacent screen. The AT&T 3050 (about $300 plus service contract), which you install on a car dashboard, and its walk-about cousin, the 3450 (about $400 plus activation), each sport a trio of buttons that point to changing prompts on a built-in two-inch screen. You use the buttons to navigate through on-screen menus. So, for example, using the forward arrow takes you to the next option; reverse to the previous option.You can expect to see this additional format appear on a variety of cordless and desktop phones as new products come out, though there are no plans at this time to formally introduce a Touchtone II identity.

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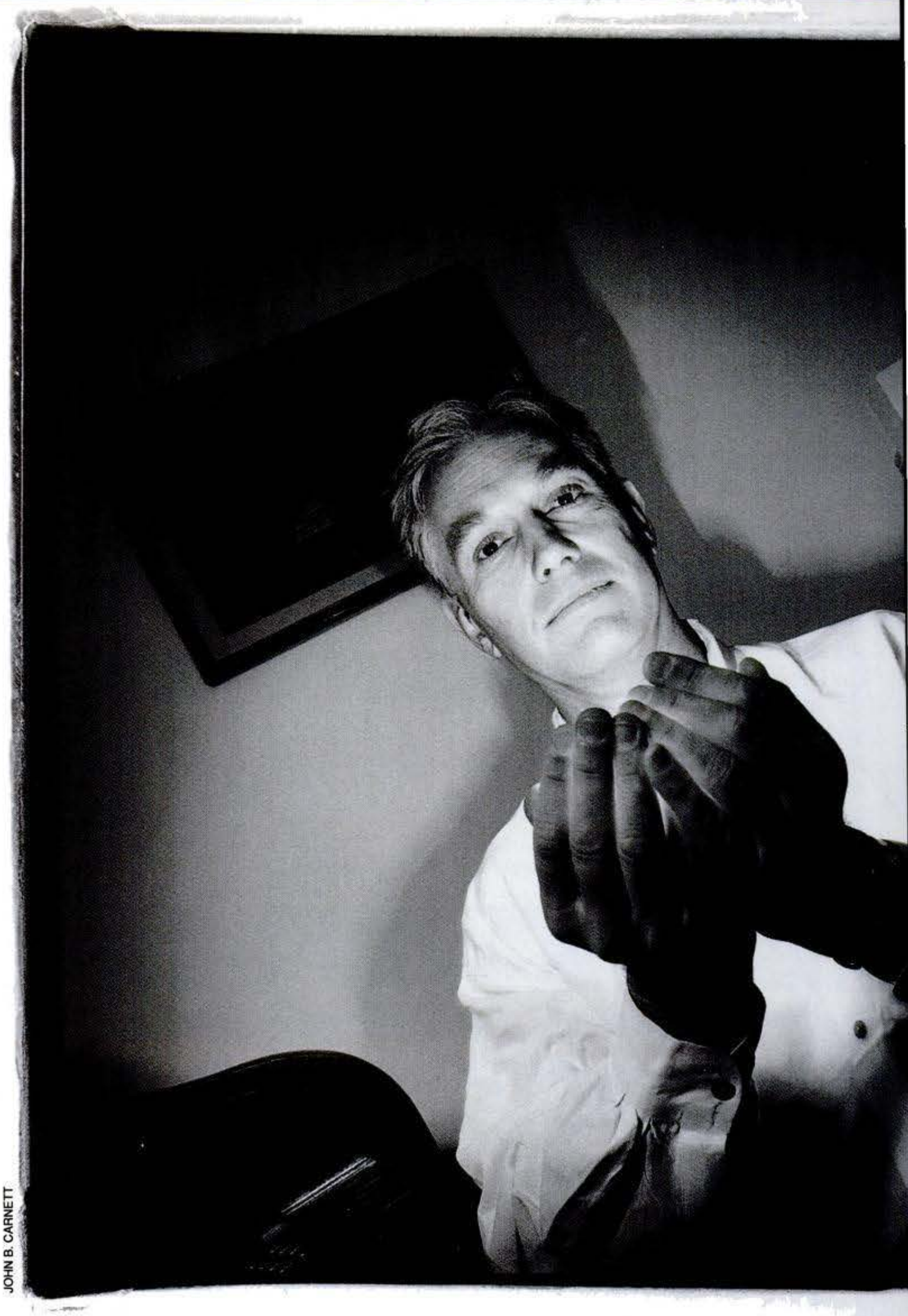
you pull into your garage, and you ought not to notice the difference. Once again, as soon as you've got that concept, what's the telephone number that you're on? Are you on the telephone number that rings in your house or on the telephone number that rings in your car? Why should it make any difference? You're talking about a lot of computing power to keep all this straight. And you're talking about some serious business issues including the potential for fraud.

What if you have a cellular phone in your car and a portable as well, and you like the hard-wired one in your car because it has three watts of power and other features. Why should you have different numbers? If I'm in my car, I'm using the one in my car. If I'm not in my car, I'm using my portable. I'm never using them both at the same time, so both of them could have the same telephone number. What if somebody steals one of them and you're both talking at the same time? If it's literally at the same time in the same area, the computer can find it and say, "That's wrong here, you've got two on the same telephone number." On the other hand, what if your spouse has one, and you have the other one? As long as it's a legitimate call, why can't you bill them both to the same number? It makes no difference. That's the classic problem we have to overcome to make One Phone a reality.

But the first step in One Phone is to understand that consumers today already don't care about the difference between a cordless phone and a cellular phone. They're both radio frequency technologies. In fact, the cordless technologies that we're just introducing now use the 900MHz frequencies that are used for cellular technologies in other parts of the world; we happen to use the 800MHz part of the spectrum for our cellular technology here in the United States. But what difference does that make to the consumer? What is the difference between a cordless phone and a cellular phone? Why is one distinct from the other? Why can't we have the One Phone concept begin with the ability to carry a cordless telephone around and be connected with whatever the network is that's the most appropriate vehicle, whether it's a cellular link or a connection to a wired base station in the house. That's the first step. Why should it matter if it's an analog cellular cell or a TDMA (Time-Division Multiple Access) or CDMA (Code-Division Multiple Access) cell ["World Phone," Mar. '94]? What if you like the CDMA capability and you're driving along a highway where there are a bunch of CDMA cells, but you cross into a rural area where there are only AMPS cells (the current Analog Mobile Phone System), because digital technology hasn't been employed there yet? Why shouldn't your phone just hand off? Why do you need a different telephone number or a different phone to do that? I have two cellular phones. One of them is programmed into the 415 area code, because I spend so much time in California, and the other is programmed for 201 [AT&T Consumer Products offices are in Parsippany, N.J.]. Why can't we make that easier to do? Somebody called me the other night at my house and asked if they could send a fax to me. I gave them my home fax number, because it's my home number plus two, which I could remember. The caller said she needed to send it to my office. I don't know my office fax number. I can't remember it. I have to get my business card and look it up. That's terrible. Why should that be so hard to do? Why shouldn't I be able to tell a special device to notify the



JOHN B. CARNETT

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switch that when this fax comes to my home, I want it sent to the office? We will get to that but the fully employed vision is many, many years away.

By the way, you may never get to one telephone number, because you may choose, for your own reasons, to have, say, three telephone numbers. You may have one telephone number that you give to very close friends and family, and that you don't want anybody else to know. You may want to be able to distinguish who it is by what number they're calling. At least, then, it's your choice, because of your personal proclivities, rather than the industry's choice, because it's technologically possible.

Are there other projects of this sort that you're working on that point the way to new classes of products, applications, or solutions?

We have a significant effort underway to build a telephone on a chip. It doesn't have the razzle-dazzle in the same sense as some other projects—but it may have a bigger economic effect over a long period of time. This was designed to encompass the rest of the world with a technological standard that we can produce and platform. The real issue for platforming something is that you don't have a separate development project for each country in which you do business. The world is divided into lots of little pieces by the tight approval standards for telecommunications. [See "Telephone on a Chip."]

A telephone on a chip implies something very small. Could the phone as we know it actually disappear?

There's a form-factor issue associated with that. We think the phone wants to be a phone. But the part of it that is the telephone is just a couple of pieces of silicon. We have some other very interesting projects to put everything—all the electronics—in carbon-based ink that we spray-paint on the inside of the plastic itself. What you think of as the telephone now becomes a relatively simple device and very reliable since it's silicon based.

One of the technologies you haven't mentioned is voice recognition, which could go to the heart of security. Perhaps with voice recognition you wouldn't need all these buttons.

We have those products today. We have voice-recognition and voice-activation capabilities on our cellular phones. We have a new phone out called Enterprise. Of course, the ability to do voice activation in a car is a lifesaver. How people talk on the phone in the car without having an accident is beyond me. In fact, in some parts of the world, it's illegal to be talking on the phone and driving at the same time. But let me extend voice-activation and recognition technology to the handwriting area. These are all very interesting technologies. My own background is as a mathematician, so I'm interested in the algorithms that are associated with how these things work.

I believe that the current capability, and probably what we can expect for at least the next five years, is going to be limited to some very special-purpose applications for both social/conventional reasons and for technological reasons. When I tell my phone in the car to "call Elizabeth," the recognition has messed up maybe twice in the last year since I installed it on the phone, and I do it everyday. We're talking a relatively small error rate. It's relatively reliable in that we have one user and a relatively small set of things that the phone is required to do. The microphone is right there, it knows where I'm sitting, it's very directionally oriented, and it works.

When you start talking about more general speaker-independent or handwriter-independent applications, these technologies begin to be pretty fragile. The industry claims a success rate for recognition of upward of 95 percent. Think about it. First, it's not true. Handwriting recognition for me is maybe 60 percent reliable. My handwriting is maybe worse than most, but it's not all that much worse. I'm not going to allow myself to be retrained for the device. The device is going to have to do the work if it's going to be acceptable to me. Asking consumers to retrain themselves is naive. It just doesn't work that way.

Think about the fact that even if it could be 95 percent —make it 99 percent—accurate, is that acceptable? One percent error is equal to almost seven words per page in typos in your magazine. You're not going to have that. Not only is that intolerable, it's inconceivable. Basically, that stinks. So 99 percent accuracy may sound pretty good but is it OK for the application of security? It really isn't.

Think about being a bank that wants to use voice recognition to verify that you are who you say you are. What are the parameters you're going to apply on the success rate? The success rate has two components: false positive and false negative. A false positive is a pretty serious glitch if somebody has just forged a check. A false negative is an annoyance to a real customer. Whoa, big time—we don't believe you are who you say you are. But the bank says it's terrific, they have the whole thing down to one percent error, even though it's going to infuriate one percent of their real customers. Not acceptable. So our ability to use these technologies in an effective way is still suspect.

I think voice recognition and handwriting recognition will have a very limited niche where they are acceptable and useful at the same time. For a while yet, we're in that realm. I love voice recognition in my car. It's private. I do a few things. I would never use it in my office. I'd rather dial the number and get confirmation that I've gotten the number I wanted. There's also the social issue that I don't talk out loud in my office. I talk aloud in my car.

The cable companies are champing at the bit to get into telephony, and the

[continued on page 81]

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URBAN OASIS

Air and water are

BY DENNIS NORMILE

Crowds and culture make Tokyo a dynamic and endlessly fascinating city, but the concentration of activity doesn't allow much room for nature. Pell-mell development has left Tokyo with less park space per resident than any other major capital.

So it was with open arms that residents of this bustling city recently welcomed a new pocket park. In a space that might have accommodated six cars, passersby can now find trees, shrubs, and a tiny artificial stream that together create a small patch of wilderness. Bird calls compete with the noise of the traffic just yards away.

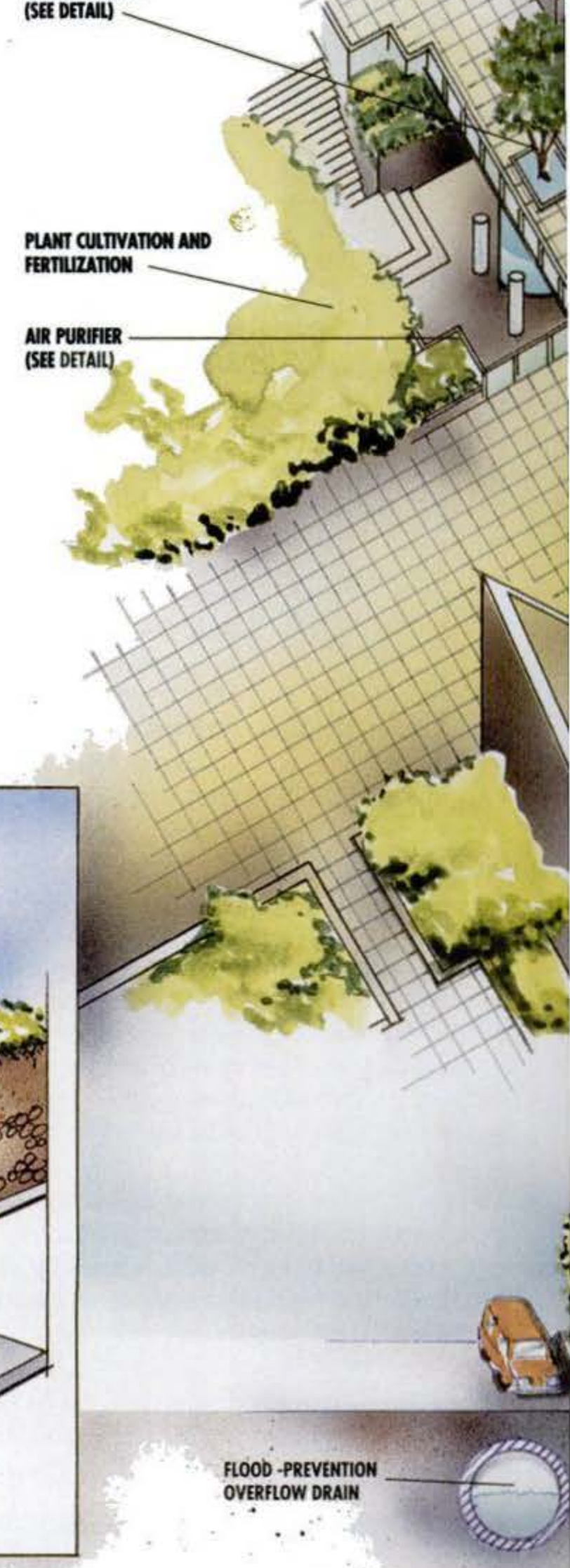
This oasis didn't happen by chance. "We wanted to show how understanding environmental cycles allows the integration of a natural environment into an urban development," says Naoaki Uchiyama, an environmental scientist who works for Fujita Corp., the construction company that built and owns the park.

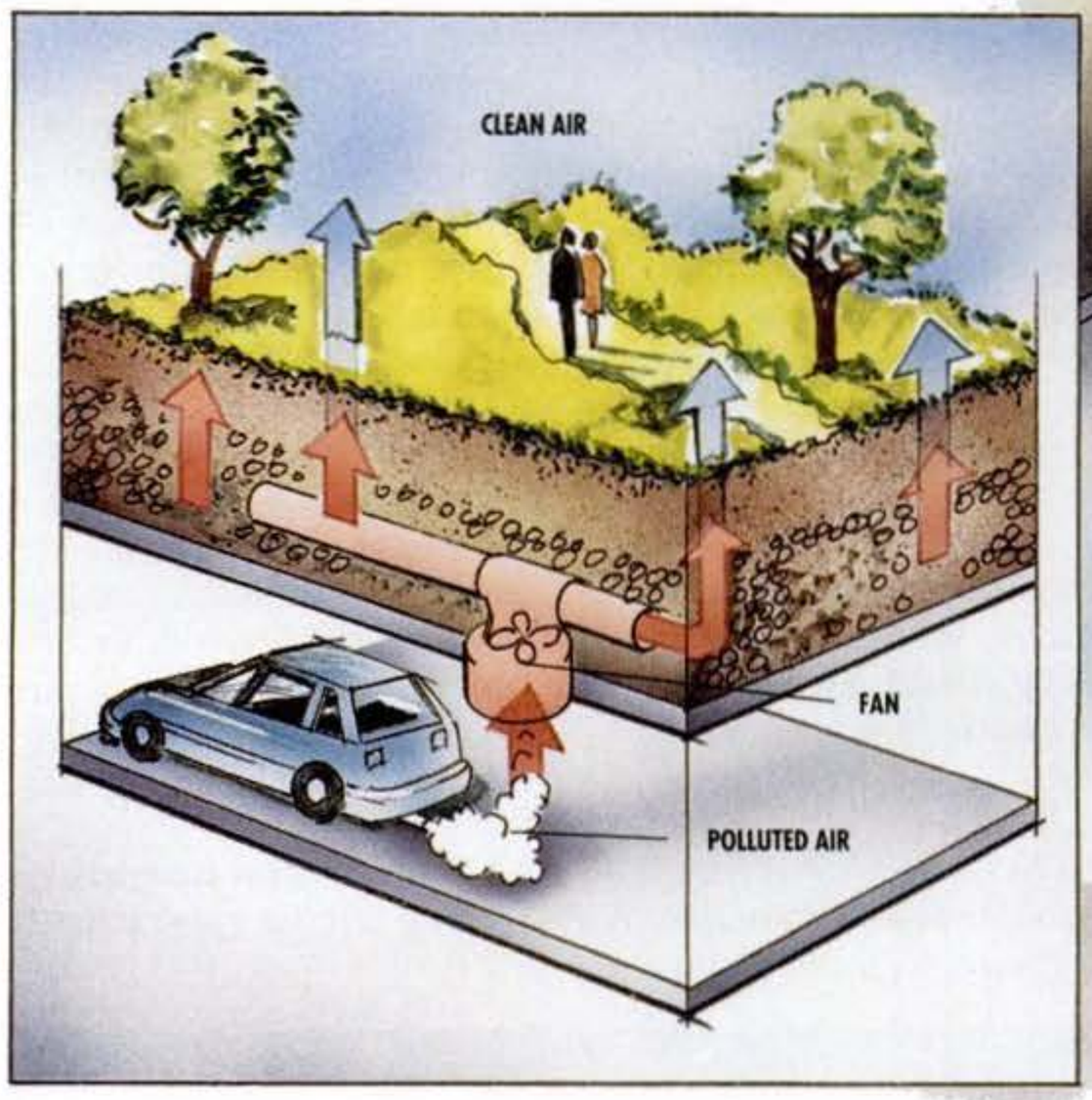
The park is just one component of an office development that also includes ten- and 18-story office towers, a cafe, and public exhibit spaces. Called Urban Oasis, the project is not only Fujita's new headquarters but is also a showcase for innovative recycling schemes.

The centerpiece of the project is a network of pipes and pumps that cuts per-capita water consumption nearly in half. Rainwater collected from the roofs, and water washed down the sinks, are reused to flush toilets. The wastewater is sent to treatment tanks, where minerals and other nutrients are removed.

About 90 percent of the water taken from city supplies is reused at least once. That reduces fresh water consumption to about 13 gallons per person per day. A worker in a typical Japanese office building uses about 23 gallons per day, according to Fujita. The building also discharges about 40 percent less wastewater into

[continued on page 86]





AIR PURIFIER

To recycle air, exhaust from the underground parking garage is forced up through two soil layers and vegetation. Air pollutants such as carbon monoxide and oxides of nitrogen are taken up by microbes in the soil, and by the roots of the vegetation. Inside the lobby, air is filtered the other way: drawn down past vegetation in planters, through a soil layer, and then back into the surrounding air.

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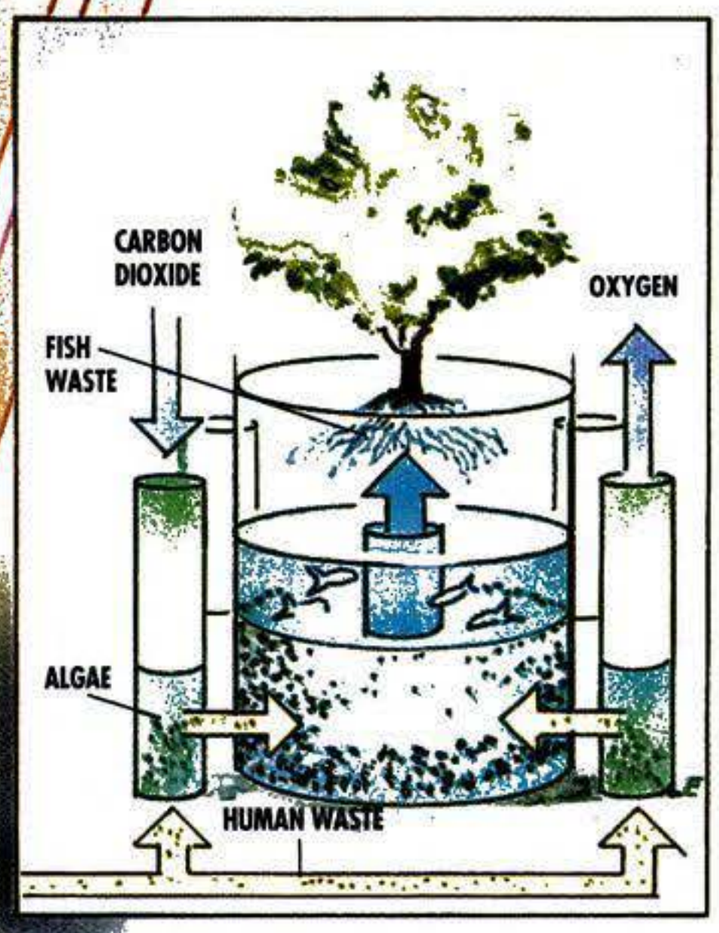
recycled at an innovative office building in Tokyo.

ATRIUM PLANTS HELP FILTER AIR

AIR PURIFIER (SEE DETAIL)

SUNLIGHT REFLECTORS



SUSPENDED TREE

Four cylindrical tanks, lit by fluorescent lights and filled with water, contain spirulina algae. These algae absorb nutrients from human waste pumped into the tanks. They also take up carbon dioxide and release oxygen. As they multiply, the algae spill over into an aquarium holding tilapia fish. The fish eat the algae, and the fish-tank effluent is sprayed on the roots of a camphor tree dangling in the air above the fish tank.

WATER RECYCLING

Employees in this building use about half as much fresh water as most office workers in Tokyo. Rainwater runoff outside the building is collected in tanks and used for fountains, ponds, and plant watering. Rainwater from the roof is used to flush toilets. Water collected from sinks and toilets goes through treatment tanks and filtration systems in a sub-basement. About 90 percent of the fresh water taken into the building is reused.

RAIN COLLECTION

PLANT WATERING

RECYCLED WATER USED IN FOUNTAINS AND PONDS

WATER PERCOLATES INTO GROUND

WATER STORED FOR RECYCLING

FILTRATION SYSTEM

PUMP

RAIN STORAGE

DIANA BRENNING

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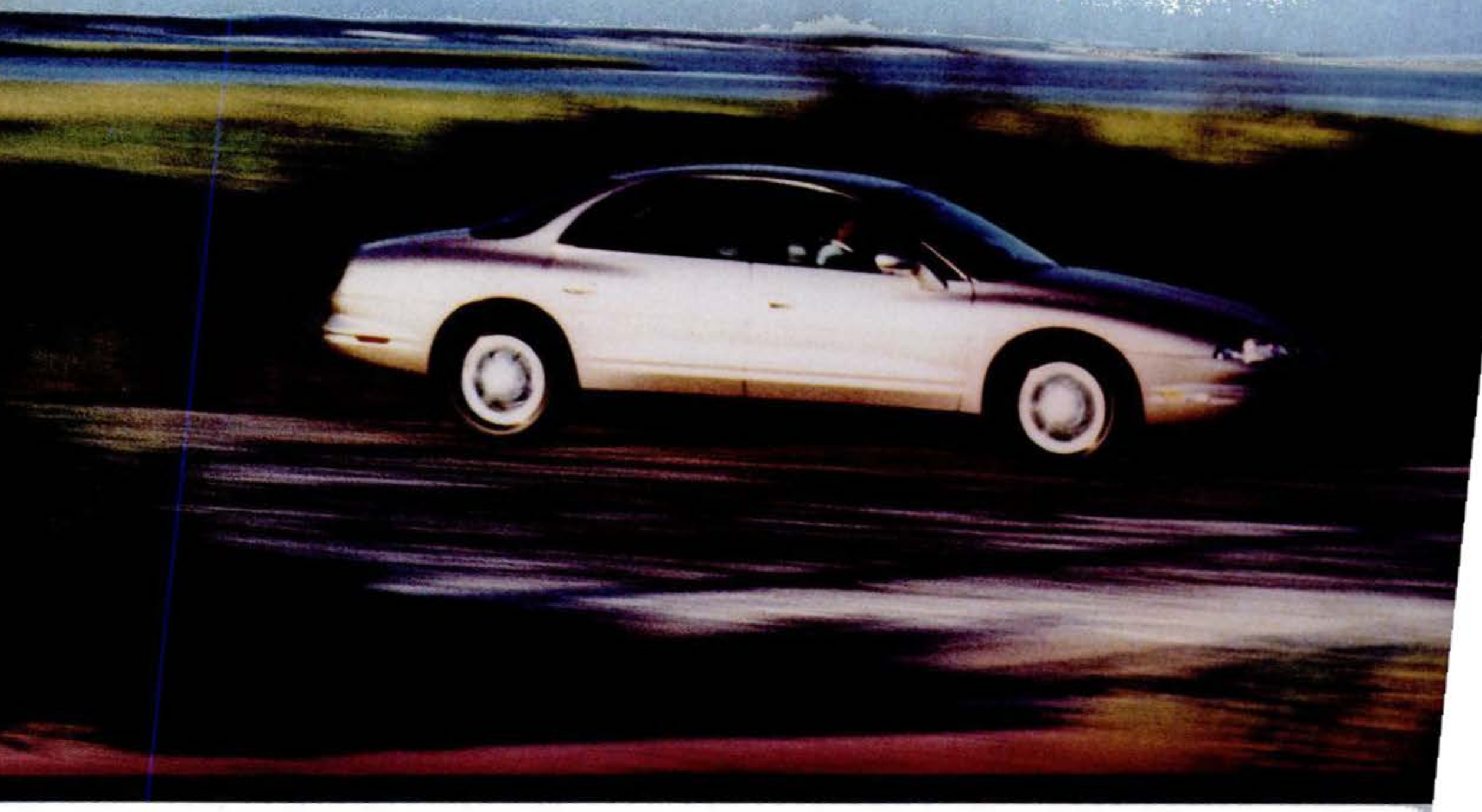
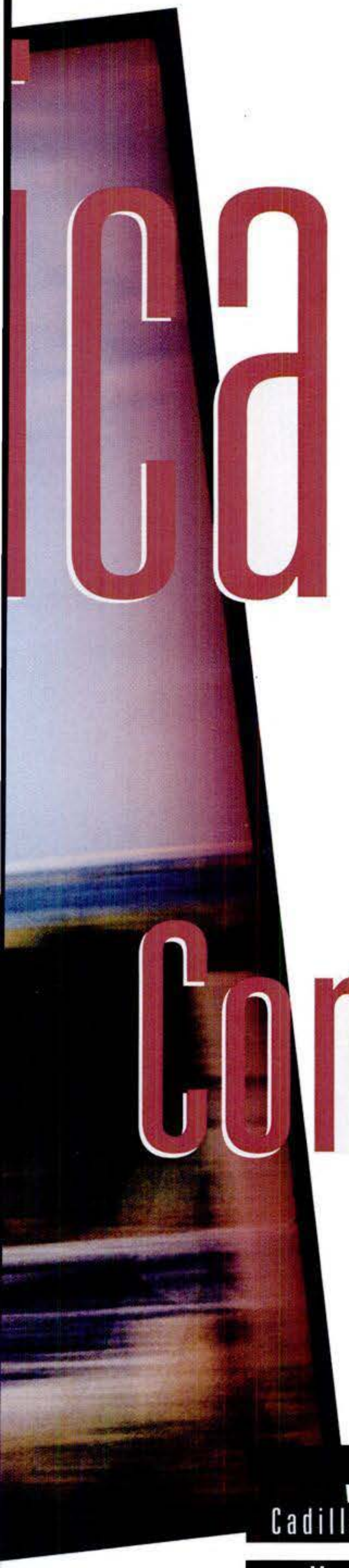
The Ame

American sports-luxury sedans challenge—and in some ways surpass—blue-blooded European benchmarks.



Cadillacs Are Coming

BY DAN McCOSH



BMW 540i

Cadillac DeVille Concours

Mercedes-Benz E420

Oldsmobile Aurora

The Oldsmobile Aurora is evidence that GM has finally seen the light.

When Oldsmobile announced that it was preparing a car that would surpass the upper echelons of European and Japanese sports-luxury marques, skeptics sneered: Could the Aurora really leap ahead of its competition? Or would it be just another turnpike cruiser?

But as details of the medium-size sports sedan with an all-aluminum V8 surfaced, it became clear that the Aurora project really was something different. Rather than a living room on wheels, Oldsmobile had wrought a compact, high-performance sports-luxury sedan.

To test how the 1995 Aurora measures up, we set it nose-to-nose against two benchmarks of European luxury performance: the BMW 540i, a polished V8-engined rear-drive car touted as "the ultimate driving machine," and the Mercedes-Benz E420, a V8 entry from the automaker's famous line of E-class performance sedans. Rounding out our field of V8 sports-luxury contestants is another General Motors product, the Cadillac DeVille Concours, fitted with the Northstar engine system and the road-sensing suspension grafted from the Cadillac Allante.

GM was aware that buyers were attracted to the small-displacement, multivalve V8s and tauter suspension systems found in Japanese and European sports-luxury models. Yet the company could not afford to turn its back on its traditional buyers, who defined luxury as ample room and protection from potholes.

To grapple with the imports on equal footing, General Motors needed stiffer bodies, a change that would improve handling and keep traditional buyers happy as well.

Designing a stiff, strong body, resistant to bending and twisting, offers several benefits. A stiff body encourages subassemblies such as the instrument panel and the door frames to act as a single unit, reducing secondary creaks and squeaks. It also provides a rigid brace for suspension tie-in points. Bushings can be tighter and suspension movements more precise.

Another virtue of a stiffer body structure is a reduction of natural vibrations caused by the complex mix of components in a car. If, for example, the buzz of tires on a road surface matches the resonant frequency of the dashboard, the result can be a low-level "boom" intruding into the passenger cockpit. The high natural frequency of a stiff structure all but eliminates this problem.

GM's push to "Europeanize" its luxury cars bore fruit with Cadillac's full-size, six-passenger, front-drive DeVille Concours. When the DeVille was due for a facelift in 1994, Cadillac chose to transform the prestige version of the DeVille, the DeVille Concours, into a new kind of performance car. This revision started with inserting a slightly detuned but still potent 270-horsepower variant of the Northstar V8 into the engine bay: a good move. The Concours, the heaviest car in our test, won top honors in three of our four acceleration trials, smoking both of the European entries.

Engineers improved handling by stiffening the Concours' body with additional gussets and reinforcing rods: another good move. Despite being the longest and widest car, it also showed well in our slalom test, nipping at the heels of the BMW 540i.

The near-behemoth DeVille Concours maintains the same strut-type front suspension with independent rear as the earlier Concours, but engineers mated it to Cadillac's new road-sensing shock system, which alters shock response while the suspension arm is still in mid-stroke. This allows for steering that is quick and clear.

But make no mistake: The DeVille Concours is a big, heavy car that sometimes shows its weight by excessive pitching when pressed hard. It handles rough pavement

PHOTOS BY JOHN B. CARNETT

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and deep undulations with a level ride, although the impact of small road bumps sometimes intrudes. The Concours now accounts for about a third of all DeVilles sold today—the kind of encouragement needed to convince GM that precise handling is not incompatible with a luxury-car feel.

Unlike the DeVille Concours, the Oldsmobile Aurora was developed as a sports sedan from the outset. Body-development engineers began with a clean sheet of paper and opted for innovative body structures and webbing designs at critical joints for added stiffness. The result: The Aurora's stiffness index is the best in GM's stable. It even ranks among the stiffest-bodied cars in the world, no mean feat for a car with a long-wheelbase design.

Aurora's engine bears a strong resemblance to the Northstar powerplant. It's an all-aluminum, 250-hp, multivalve V8 with 4.0-liter displacement.

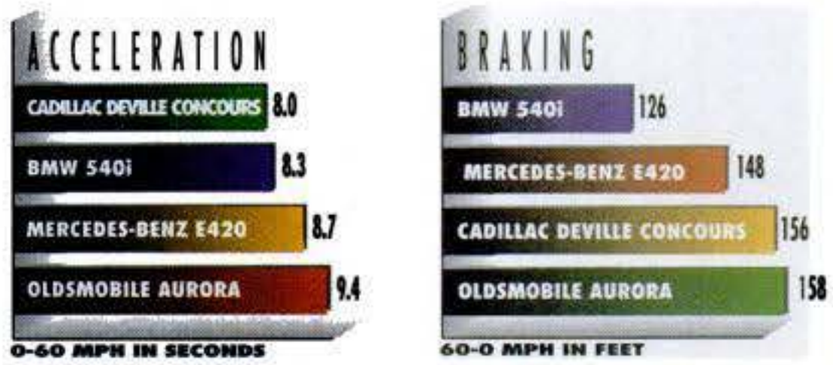
The downsized Aurora engine produces less power and torque than the Northstar, giving it the slowest zero-to-60 mph in the group and poor performance in our other acceleration indicators. The Aurora engine shares the free-revving spirit of the Northstar, however, and if anything, it runs even smoother.

The engine is matched with an electronically controlled transaxle that adapts to altitude and load conditions. A standard antilock braking system is accompanied by brake-gripping traction control for full electronic management of the tire/roadway interface. The Aurora turned in only mediocre performance during warm-braking maneuvers, however, and by the time the brakes were hot, they were fading rapidly.

Road feel in the Aurora is exceptional. Variable-ratio, rack-and-pinion power steering with a magnetic actuator gives a smooth, linear feel to the steering. This, and a finely tuned suspension linked to a rigid chassis, gave the Aurora what it needed to net top honors in our slalom test and a close second in the double-lane-change test.

The Aurora is roomy, but with its weight and bulk, it falls a bit short as a flat-out sports sedan. Seating position is comfortable and supportive, but road view is over a relatively high cowl. Unlike the Concours, which makes no pretensions about being a sporting sedan although it performs like one, the Aurora has the shape and stance to raise one's expectations, but falls short.

Both of these high-performance GM luxury sedans skirt the edges of territory pioneered by BMW and Mercedes. The German marques are models of rigid body structure and use it to help support a stiff suspension. Both also are rear drive, which some drivers like



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(From top to bottom): Aurora's dash curves toward the driver, imparting a tight cockpit feel behind the wheel without cramping other passengers. Walnut inlays on the dash and console contrast nicely with the Mercedes-Benz's rich leather interior. The businesslike interior of the BMW is slightly softened by wood inlay across the dash and on the console. Seats are narrow but supportive. Sparse, quiet, and rectangular describe the DeVille Concours' interior. The seats could have been lifted directly from the first-class cabin of a DC-10.

but which radically alters the handling characteristics.

The BMW 540i comes to bat with a 282-hp, 4.0-liter aluminum powerplant originally developed for BMW's 7-series sedans. Yet this car, with the most powerful engine in our test, consistently fell a blink or two behind the Northstar-powered Caddy in acceleration. The lightweight engine makes the 540i the best-balanced car of the bunch, with just 52 percent of the vehicle weight on its front axle, but this is a double-edged sword: The combination of even weight distribution, rear drive, and ample power makes it easy to steer with the throttle but also demands driver finesse. The 540i is prone to hanging its tail out if the throttle is suddenly lifted in a corner, a characteristic that relegated it to last place in our double-lane-change test. On the other hand, the BMW's ventilated disc brakes won it the best braking performance in our group by a substantial margin.

The 540i's front suspension is an unusual double-pivot design, which allows some small rearward movement to absorb shocks. Still, the suspension is stiff by U.S. luxury car standards and is the only downside to one of the most responsive suspension setups of any car on the road.

The BMW's new V8 is coupled with a five-speed automatic or five-speed manual transmission with overdrive. The extra gear in the automatic doesn't much improve gas mileage—the BMW is a gas-guzzler and is taxed by Uncle Sam as such—but smooths out upshifts. If violent

Engineers worked especially hard to design a stiff body structure for the 1995 Oldsmobile Aurora (opposite page, bottom) to optimize handling and response. Thanks to its all-aluminum V8, weight distribution on the BMW 540i (opposite page, top) approaches perfection. A stiffer body for the 1994 Cadillac DeVille Concours (above) improves the car's handling. Optional traction control hobbled the Mercedes-Benz E420 (left) in performance venues, cutting in long before the tires reached their traction limit.

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maneuvers are avoided, the BMW radiates balanced, poised performance. Just make sure you've graduated from a high-performance driving school if you intend to push this car.

Compared to the overall harmony achieved by the BMW, the Mercedes-Benz E420 hits a discordant note. The rear end tends to sway when the throttle is lifted in a corner and the traction-control system cuts in early, well before the tires reach their cornering limit.

On the upside, steering is light and direct and the car responds easily to throttle inputs. The ride is even firmer than that of the 540i, and this gave the E420 its only first-place finish—in our double-lane-change challenge.

Despite the similarities in basic design, the 275-hp, 4.2-liter E420 V8 produces less power than the BMW 540i. This diminished power yielded a second-to-last finish in zero-to-60 performance, nearly a second off the pace set by the Cadillac DeVille Concours.

The Mercedes is both larger and lighter than the BMW, yet it retains a sense of body integrity matched by few cars. The precise handling and lively performance sets the two German makes in a class by themselves on winding roads. But in raw acceleration, the DeVille Concours beat all comers—an incredible feat for a full-size Cadillac sedan that would look at home with ambassador's flags on the fenders. And the Aurora, despite sporting the smallest engine in the group and lagging behind in acceleration prowess, managed to snake through the slalom cones with gusto that left the German marques trailing behind.

The Aurora is the American car closest to upsetting the smug, top-of-the-ladder position enjoyed by the German automakers, but it trades optimum performance for roominess. Its $32,000 price tag, about two-thirds Mercedes' range, makes the Aurora the best value.

The gulf between American and European driving experience thus narrows, although it doesn't quite disappear. Efforts such as the Oldsmobile Aurora and the Cadillac DeVille Concours show that GM is heading in the right direction—fast. PS

NORTHSTAR: THE ENGINE THAT WON'T DIE

V8 engines are inherently smooth and relatively compact. Equipped with modern combustion chambers, valve-trains, and electronic systems, they can be reliable and efficient. While the performance and personality of each car in this comparison varies dramatically, the engineering under these four hoods is so similar you might suspect shared blueprints. In fact, that's precisely the strategy used by Cadillac and Oldsmobile.

The GM Northstar V8 design most impressed me, in part because of a convincing demonstration of its limp-home capability. When a technician loosened one radiator hose to drain the car's cooling system of its lifeblood, I took the car for a test drive and accelerated up to freeway speeds. After a few miles, various warning messages appeared in the instrument cluster, followed by a slight increase in roughness, and finally, a noticeable loss in power. It took full throttle to cruise at the 55-mph speed limit, but the test car showed no other signs of distress. Inside the Northstar V8, four cylinders were hard at work while four rested. The powertrain control computer swapped teams at regular intervals to keep the internal components cool without benefit of liquid refreshment.

These days, the number or the size of the pistons under the hood isn't as important as it once was. What matters more is the electronic intelligence packed within the powertrain control computer and its ability to keep those pistons pumping no matter what.—*Don Sherman*

POPULAR SCIENCE TEST RESULTS

	BMW 540i	Cadillac DeVille Concours	Mercedes-Benz E420	Oldsmobile Aurora
ACCELERATION and HANDLING				
0-30 mph (sec.)	3.7	3.9	3.3	3.6
0-60 mph (sec.)	9.4	8.7	8.0	8.3
30-50 mph (sec.)	3.9	3.4	3.1	3.9
50-70 mph (sec.)	5.4	4.8	4.6	4.2
Double-lane change (mph)	56.3	57.2	55.2	54.5
Slalom (mph)	45.2	41.7	43.9	44.6
BRAKING				
Cold (ft.)	146	148	151	131
Warm (ft.)	158	148	156	126
Hot (ft.)	183	155	161	132
INTERIOR NOISE				
Idle (dB)	42	45	41	49
60 mph (dB)	71	72	72	73
0-60 mph (dB)	67	66	67	69
SPECIFICATIONS				
Engine	4.0L V8	4.2L V8	4.6L V8	4.0L V8
Valve train	DOHC 4 valves/cyl.	DOHC, 4 valves/cyl.	DOHC 4 valves/cyl.	DOHC 4 valves/cyl.
Power (hp @ rpm)	250 @ 5,600	275 @ 5,700	270 @ 5,600	282 @ 5,800
Torque (lb.-ft. @ rpm)	260 @ 4,400	295 @ 3,900	300 @ 4,000	295 @ 4,500
Compression ratio	10.3:1	11.0:1	10.3:1	10.0:1
Transmission	4-speed	4-speed	4-speed	5-speed
Final drive ratio	3.71:1	2.24:1	3.11:1	2.93:1
CHASSIS				
Front suspension	MacPherson strut, coil springs, antiroll bar	Strut-type, coil springs, antiroll bar	MacPherson strut, coil springs, antiroll bar, electronically controlled shocks	MacPherson strut, coil springs, antiroll bar
Rear suspension	Independent, semi-trailing arm with lateral link, coil springs, antiroll bar	Independent, multi-link, coil springs, antiroll bar	Independent, unequal-length control arms, coil springs, antiroll bar, electronically contolled shocks	Independent, semi-trailing arm, coil springs, antiroll bar
Steering gear	Rack-and-pinion, power assist	Recirculating ball, power assist	Rack-and-pinion, power assist	Recirculating ball, power assist
Turning circle (ft.)	41.0	38.4	41.0	36.1
Brakes (front, rear)	ABS; vented disc, disc; power assist	ABS; vented disc, vented disc; power assist	ABS; vented disc, disc; power assist	ABS; vented disc, vented disc; power assist
EPA MILEAGE				
City	17	18	16	16
Highway	24	24	25	23
DIMENSIONS				
Wheelbase (in.)	113.8	110.2	113.8	108.7
Length (in.)	205.4	187.2	209.7	185.8
Width (in.)	74.4	68.5	76.6	68.9
Height (in.)	55.4	56.3	56.0	55.6
Curb weight (lbs.)	3,940	3,760	4,000	3,800
Distribution % (front:rear)	63:37	55:45	62:38	52:48
Fuel tank (gal.)	20.0	18.5	20.0	21.1
Interior volume (cu. ft.)	102.3	89.6	117.5	88.0
Trunk volume (cu. ft.)	16.1	14.6	20.0	16.2
PRICES, PARTS, AND LABOR				
Base price	$31,370	$51,000	$36,590	$47,500
Price as tested	$31,765	$53,500	$38,905	$50,220
Major options (over $100)	V-rated Michelin radial tires, $395	Traction control and heated front seats, $2,500	Chrome wheels, $1,195; CD sound system, $396; heated windshield, $309; antitheft system, $295; heated front seats, $120	Traction control, $1,350; gas guzzler tax, $1,000; heated front seats, $370
REPAIR: PARTS/LABOR*				
Front brake pads	$ 82/29	$ 108/37	$ 73/45	$ 87/74
Front shock/insert	104/43	254/64	536/61	253/97
Alternator	246/91	1,110/53	NA/50	392/74
Water pump	88/43	326/228	104/84	174/68
Windshield	800/120	382/281	59/72	367/165
Headlamp assembly	10/19	420/58	111/28	123/17

*Labor costs reflect manufacturer's flat-rate time allowance multiplied by typical dealership labor rates per hour.

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The future is now

[Continued from page 73]

phone companies to get into video delivery. Which is the easier way to go technically? And how does this role reversal translate into consumer choices?

We are already in the video business. We make switches that switch broadband. If you're talking about delivering video over a twisted pair of analog copper lines, it may be a different question, or maybe it's the wrong question. The difficulty with the cable approach is that it's an approach of many pieces. There is no single cable network. There is no single cable standard. Cable companies have come in with an approach that is essentially proprietary, since the cable company controls access to whatever programming is offered. It's very different from the telephony view of the world, which is open standards—being able to attach anything that will work on the network and being able to use it.

We have a tremendous research and development capability inside of AT&T. I'm very proud of it and constantly point out it's one of our great strengths. But I also point out to people, even over at Bell Labs, that most of the smart people in the world work someplace else. That's actually a great advantage. When you have a very open, very usable standard capability, you get lots of other smart people contributing things to it; they're making a profit of it by their own intelligence, their own invention, and their own entrepreneurship. That's the way it should be in our economy. The control standard is different. You can't watch a movie on cable network unless your cable operator is offering that movie. What if you wanted to see a movie that was owned by a competing cable network, which is increasingly the kind of thing they're doing. You're not going to get that movie. The cable operator doesn't want you to see that movie because it's not something he gets paid for.

We have a different point of view. We prefer for you to be able to shop in an open environment for whatever it is you want, whether it's video or data, and receive it in the cheapest and most effective way on whatever device you look at it. That's the point of view we bring. We're developing those capabilities. It's probably safe to say that AT&T is into the convergence of computing and telecommunications across various kinds of telecommunications more than anybody else in the world. Our world now is not just telephony, but telephony as well as data of all forms, video, and all kinds of messengering services. We do all of that now and will continue to do it all. Our corporate strategy for the last couple of years has been "anytime, anywhere," And I think you could add "anyway."

Does that mean the company is taking a shotgun approach to developing technology in the absence of a clear strategy and vision?

We certainly do have a clear strategy and vision, and it has to do with centralization and concentration on communications. But communications is broadening. A few years ago we would have said the communications business is voice telephony. That's not what we say anymore. We're broadening the horizon but are still quite restricted to the communications capability that we think of as the foundation of our business.

But with respect to the other observation that there are a lot of different things that we're in now, when you're a company our size, that's a necessary component of the strategy as the market develops in such new ways. We need to have a lot of little bets down. We need to be investigating practically everything that's important in the telecommunications industry, because wherever the next big growth opportunities are, when you're a $60 billion-plus company that intends to grow its earnings by ten percent annually, you've got to find big markets. And those big markets are going to develop in ways that are unpredictable; they're not always technology-driven, or at least not solely technology-driven. What's the right flavor for the consumer?

Which are the new technologies and new ways people will be dealing with information, that you see as the ones that will make the biggest differences in our lives?

Well, I certainly think wireless technology is one. It is one of the fastest-growing components in the telecommunications industry today because people like the idea of being untethered. I don't see any way to stop it. Users are increasingly intolerant of the differences between the various kinds of cellular technology, cordless technology, Personal Communications Services technology. They don't care. They don't care what the bandwidths are. They don't care what the technological issues are. They don't care if it's by satellites or whatever. They just want it to work. And the industry's imperative is to find ways to make it work smoothly. There's the key area of growth that's going to be a sustaining area for years.

Another is the application of intelligence in devices that consumers have with them, either mobile devices or devices that are connected into their homes. The theme that is at stake here is that users want intelligence in the device to help them make optimal choices for their own profile, personalized, specialized to their own needs and desires, among the information that is out there on various networks. They don't want to have to worry about which network, which protocol, which style, whether it's cable, copper, or satellite. They just want it handled for them. Getting exactly the right product mix, the right prices, the right features that are really worth what they cost is the challenge.

What about entertainment devices?

I think of certain entertainment as being a kind of a message. A movie is a very long message. Imagine a few years hence, movies could be delivered in a packet just like other kinds of messages. When bits are flying around the network, the network is essentially indifferent to what's in those bits. So, in terms of delivering things that you watch, sort of a passive kind of message, I don't think there's any difference there.

If you're talking about gaming, where you might have some sort of interactivity, I think the crucial issue is to observe the following thing: First of all, although there are many services we want that are interactive, there are very few that are interactive symmetrically. The amount of bandwidth that has to go in one direction is not the same as the amount of bandwidth that has to go in the other direction. Shopping can be offered to you looking at a TV set. You need a lot of information—video bandwidth—on the way down. What do you need on the way back up? Basically, you're saying yes/no. I'll buy this. I'll take two of these. That's not very much bandwidth. So the asymmetry of bandwidth is a crucial thing to bear in mind when you evaluate what kinds of services are going to be useful.

Number two: Suppose there's a service that's so valuable that you use it

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PARTNERSHIP FOR ENVIRONMENTAL EDUCATION

The future is now

[*Continued from page 81*]

very frequently. Let me imagine weather maps, and you want to know what the weather's like in Cleveland because you're flying to Cleveland. Or your commuter route to work. Or your stock portfolio. You don't need the entire New York Stock Exchange, NASDAQ, AMEX, and all the other international exchanges sent to you every ten minutes. What you want to know is, what are the prices of your portfolio stocks or your options twice a day. Not very much bandwidth is required there. And you could also specialize the screen display. You could have everything but the actual numbers already there, resident on the device rather than sent to you on the network. Why would you have to have the entire map of your commuter route to work sent to you everyday over bandwidth? You don't. You know what the map is to work. You want to know that the intersection of I-287 and I-80 is clogged up. Send a red bit for that. There's the red dot on your map. How much bandwidth does that take? An enormous amount of the information we need to deal with could be contained in the device itself with only a very small part of it being sent over the network. There's enormous cleverness associated with putting that software in the devices and connecting those pieces of software to the software that's in the network. Understand that it's a seamless, connected capability rather than some kind of transmission and some kinds of appliances.

Have you been reevaluating your position with 3DO in light of its slow start and disappointment to a lot of people critically as a new product?

Well, we reevaluate everything we do all the time. We are not at all discouraged about the category that these projects represent. These are categories that have legs. Whether it's a specific instance of the category is not the issue for us. We're more than 100 years old and we are in the most important industry in the history of the world—the communications industry—for the century; not just for the decade, and certainly not just for the year. We know that some of the experiments we try will not be successful. We actually regard the ones that aren't successful in a different way, perhaps, than the outside world does. We're spending a lot of money to learn and sometimes learning comes from a particular project that doesn't work. But that doesn't mean the idea behind it won't ultimately be successful.

We retain our investment in 3DO and we continue to be hopeful about its success. But we are absolutely intent on making a success out of the category that 3DO represents: interactive device capability. We have a technology that AT&T owns called VoiceSpan, which sends data and voice over a single line. We think this is a good capability. Whether it's interactive games or it's interactive activity of another kind, we'd love to see VoiceSpan-like capabilities incorporated into future products so that you and I could carry on a telephone conversation at the same time we were writing notes to each other; exchanging data on the same analog line.

The video phone is another example. People often speculate that we're going to give up on it. Our observation: absolutely not. Our video phone was expensive for the consumer market and it operated at a video standard below the level that people have come to expect by comparison to the television set. But we have the best video-compression capabilities in the world. We can send video at pretty high rates over a twisted pair. You'll see a next generation of video phone just as you'll see a next generation of the category of products represented by 3DO. And we will continue to develop these ideas until we find ways of doing them very cost effectively and in the form factor that's acceptable to the consumer.

How do you recommend that ordinary consumers deal with what seems like an onslaught of converging—and confusing—communications technologies?

My advice in all contexts like this is ignore the hype and pay attention, instead, to the things that are interesting to you. And a shrug of the shoulders is occasionally a good way to attack it. Let's see it happen. Be quick to get on the bus when the bus comes with something that you want. For the rest, smile and say that it's an interesting world.

I find myself acting as a consumer more often than I act as a technologist in a lot of instances. There's no danger that the AT&T company is going to miss the technological curve. We've got Nobel laureates, the world's best engineers, patents. The crucial issue is how do you bring to bear market judgment to what consumers will actually use. So my team here makes jokes. They call me more a vicious consumer than I am a vicious technologist. And that's the right attitude for everybody to have. PS

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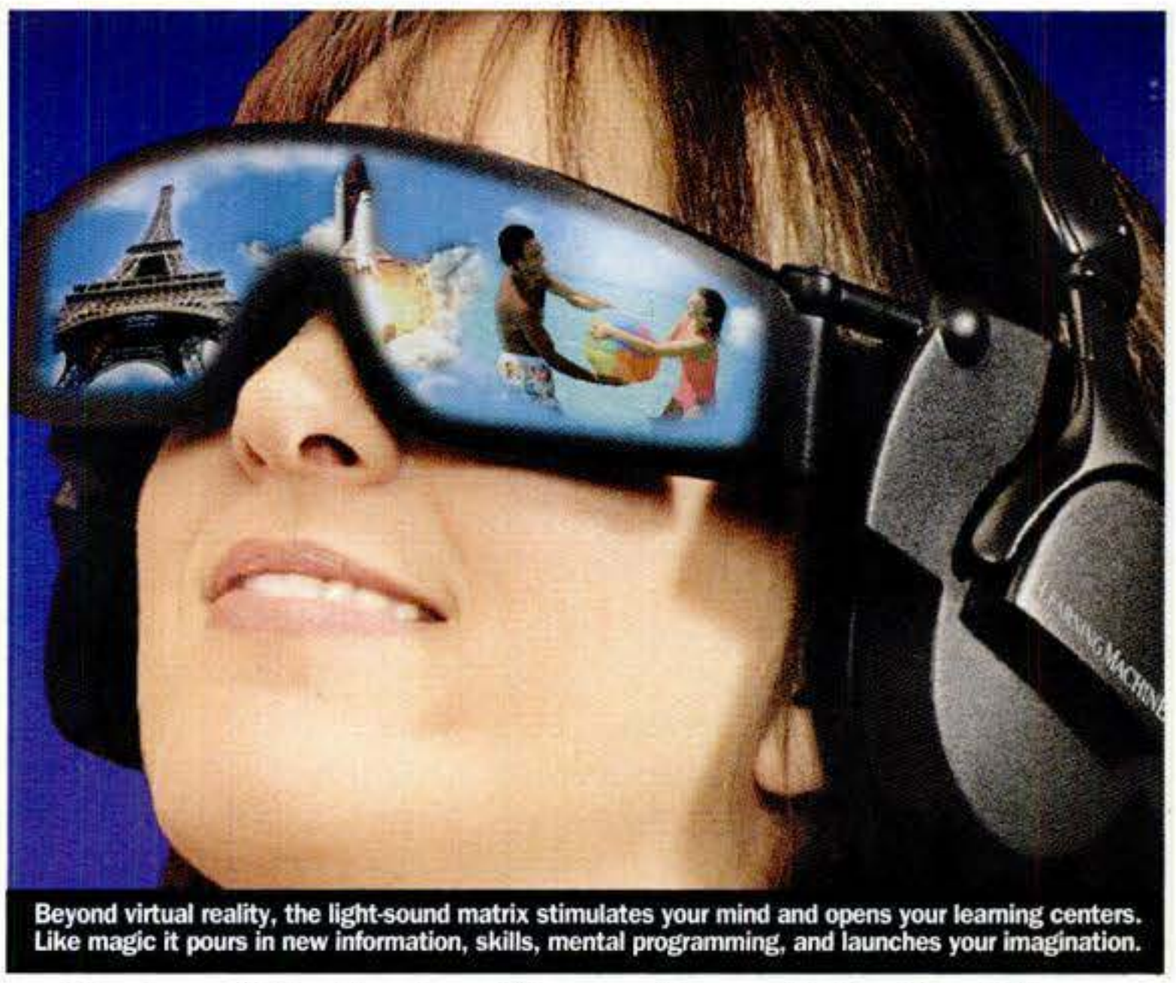

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Little dish TV

[Continued from page 64]

ceivers are already equipped to work with the MPEG-2 standard, but programmers at DirecTv and USSB have been using the older MPEG standard. When they switch to the more advanced standard, the picture will improve. PrimeStar, which currently uses General Instrument Corp.'s Digi-Cipher data-compression technology, plans to switch to MPEG-2 by the end of this year.

DSS programmers are also working on a technique called statistical multiplexing that will assign data rates by programming type. Basketball games and other fast-action programs that require a lot of video data will be assigned to wide lanes on the satellite information highway. But movies, in which the picture doesn't change as much from one frame to the next, will be compressed to fit into much smaller lanes. Cartoons require even less room.

By varying the amount of data allocated to each channel, engineers will not only be able to improve the picture for fast-moving programs, they will also be able to increase the number of channels offered. And early this year, DirecTv will put up a third satellite that will provide some additional capacity while serving as a "spare" for the first two satellites.

How will consumers choose between the two emerging digital systems? Low startup and maintenance costs are the biggest reason to opt for PrimeStar. "We think that leasing makes sense to the majority of individuals in the target audience," says spokesman Al Levy. But for people who view satellite dishes as eyesores, DSS is the clear winner. Tacked under an eaves, or strapped to a chimney, it's barely noticeable. DSS also comes out ahead in programming, with twice as many channels as PrimeStar for about the same price.

It is possible that the price of the DSS receiver will come down in another year. Thomson has licensed Sony to produce its own DSS unit after one million RCA units are sold, or 18 months after the first dish went on sale, whichever comes first.

Other high-power satellite systems are on the way too. A company called EchoStar plans to launch its first satellite in the fall of this year, and a second one in 1996; both have already been ordered from Martin Marietta. EchoStar intends to provide 77 channels per satellite to 18-inch dishes and set-top boxes selling for less than $500 retail.

Meanwhile, PrimeStar is considering a switch from its current medium-power satellite to one or more high-power satellites. The company has an option to take over a license for a high-power satellite slot. Alternatively, PrimeStar may add a higher-power satellite in the Fixed Satellite Service band where its current satellite operates. Either way, the company promises it will offer 150 channels by 1996. Subscribers will keep their existing equipment, although their dishes may have to be tilted to face a new satellite.

New programming is also coming. USSB is planning to introduce its own superstations, similar to cable superstations such as WGN. "The idea is to create a couple of national TV stations," says Blum of USSB. USSB also plans to develop what it calls Mini-Mass programming aimed at niche markets, like opera fans. There aren't enough of these fans to make opera profitable for local broadcast stations, but if all of the nation's fans could be gathered into one satellite audience, their subscription fees could support an opera channel. "That's the kind of programming we believe will be unique to direct-broadcast satellite," says Blum.

Satellite programmers may also offer data services to subscribers. The PrimeStar and DSS receivers both come with data ports that could be used to receive stock quotes or weather information, to order tickets, download video games, or shop at home. The systems already have built-in mailboxes that allow programmers to send personalized messages to subscribers.

The DSS receiver is also compatible with high-definition television systems under development, but you'll have to replace your TV set to take advantage of HDTV's greater resolution and wider aspect ratio. Thomson envisions the point-and-select DSS system becoming part of an interactive "digital TV center" that would be as easy to use as today's television sets. "In our view," says Thomson executive vice president Joseph P. Clayton, "the RCA DSS receiver/decoder is typical of a first-generation digital interface for tomorrow's home-entertainment center."

For that reason, Thomson is aiming its product at cities and suburbs as well as rural areas. And in fact, many disgruntled cable subscribers are already switching to satellite delivery. Paired with rabbit ears or basic cable to get local channels, a little dish TV system may be the best reason yet to unhook or reduce your cable service. PS

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Reinventing the telescope

[Continued from page 59]

Clusters of small, pistonlike devices called actuators are mounted behind the deformable mirror. In the 1.5-meter Starfire telescope, 241 actuators are each spaced seven millimeters apart. These devices push and pull to reshape the mirror 9,000 times a minute, although the mirror's surface actually flexes far less than the width of a human hair—only a couple of microns. (A micron is one millionth of a meter.) To the naked eye, the mirror doesn't appear to move.

The 3.5-meter instrument will require a larger, eight-inch-diameter deformable mirror with many more actuators—a total of 577. It will also have a more-powerful sodium laser to zap sodium atoms circling Earth at 90 kilometers (56 miles), illuminating them in an orange beam much like electricity flowing through a sodium-vapor streetlight. The resulting guide star will lie above most of the atmosphere, making it much more effective for image correction.

While lasers provide a clarifying boon for astronomy, there is also an accompanying bane: A limitation of the technology is that it sharpens only a small field of view. Adaptive optics can help resolve just one star at a time, or a portion of a planet the size of Jupiter. The technique is also susceptible to what are called tilt problems. These occur when atmospheric turbulence causes the laser beam to wiggle slightly as it travels upward, making it tricky to stabilize the laser's focal point. Another limitation results from the narrow angle of view that adaptive optics can correct, called focus anisoplanatism. The effect is roughly analogous to the blurring that you might see around the edges of the field of view in cheap binoculars.

Fugate says that the ultimate challenge, however, is developing adaptive optics to work in visible-light wavelengths. The technique already works fairly well in infrared wavelengths, which are longer and less vulnerable to atmospheric distortion. But to work in visible light, the laser-guide-star beacon must be 25 times brighter than for infrared—and that requires engineering and building vastly more-powerful lasers. The task might even entail using multiple lasers that are focused together to create a single ultra-bright beacon.

As astronomers push toward those shorter wavelengths, adaptive optics will also require larger deformable mirrors that have more actuators. The world's biggest telescopes probably would need deformable mirrors that are more than twice the diameter of Starfire's, perhaps 18 inches across, with as many as 7,000 actuators. These are complex design and engineering challenges that nobody has even roughed out on a drawing board yet.

Future challenges aside, the work accomplished to date remains impressive. Before I depart from Starfire, Fugate shows me images made in infrared light with the 1.5-meter instrument that are as good as those from the Hubble Space Telescope. One, depicting the Trapezium region in our galaxy's Orion nebula, contains stars with mysterious cometlike trails, gaseous envelopes that have never before been seen. The finding will add to astronomers' understanding of the nebula. Fugate is confident that the 3.5-meter telescope will produce still more dramatically improved images.

"When the adaptive optics are installed," he declares, "this will probably be the highest-resolution telescope on the planet." PS

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Urban oasis

[Continued from page 75]

the city sewer system than an average building.

The nutrient-rich solution recovered from the toilet water is also reused. Some of this liquid is used to fertilize plants surrounding the building. The rest is piped into algae tanks in a sunken courtyard. The tanks are part of an exhibit that shows a food chain in action: The algae consume the nutrients in the wastewater, multiply, and become food for fish. Fish wastes are in turn sprayed on the roots of a tree suspended above the aquarium. The system is self-perpetuating. Successive generations of fish are born and mature. Older fish are periodically removed and placed in a pond at another site. "If we ate them, it would really complete the cycle," Uchiyama says.

Even more unusual is a scheme for recycling air. Fujita scientists are using soil and vegetation to cleanse air inside the building's lobby and to filter air pollutants out of exhaust air from the underground parking garage. Sensors show that the garage system removes about 90 percent of the carbon monoxide in the exhaust air.

Unlike the water-recycling system, the air purifiers are for demonstration purposes only. Japan's building code requires that air within an office be replaced ten times per hour. Although the Fujita purifiers clean the air, they do not replace the air quickly enough to meet the requirements, so a conventional ventilation system is installed in the building. But the purifiers are attracting attention from local governments, which want to use them in public parking garages and along heavily traveled roadways. The effectiveness of such applications is yet to be proven, though, and a major stumbling block is procuring the land to provide sufficient soil and vegetation.

The water-recycling system also creates some extra costs. The pumps and treatment facilities that help conserve water mean the Urban Oasis uses more energy than a typical office building. "On this first project, we wanted to verify the viability of these systems," Uchiyama says. "Now we're looking at ways to make them more energy-efficient."

The Urban Oasis approach could help future developments counter environmental problems that arise wherever people and cars are concentrated. Green spaces might even lure wildlife to cities: Over the course of a year, 16 bird species are expected to visit the Urban Oasis. This, more than anything, shows how proper planning can make cities more livable. PS

Swing wing

[Continued from page 56]

namic drag-reducing delta shape suited for supersonic flight.

Building stealth into an airplane that can change the sweep angle of its wings poses a thorny technical challenge. As wing sweep changes, so do the directions in which the wing edges reflect radar beams. Designers can greatly simplify the radar-visibility problem, however, by concentrating on perfecting the airplane's shape with its wings fully swept. That's how the craft will look when it comes within range of hostile radars during an attack mission. The touchy part is minimizing radar reflections from the areas where the pivoting wings are joined to the fuselage.

The swing-wing plane has Northrop written all over it—not literally, but in its shape. It has major features in common with the YF-23, Northrop's losing bid to replace the Air Force F-15 fighter. The A-17 shares the YF-23's underwing air inlets; the humps atop the aft fuselage that conceal its deeply submerged engines, and the long, infrared-suppressing troughs used to cool exhaust by mixing it with fresh air. The bomber may have been secretly developed alongside the YF-23, or may have even preceded it and inspired elements of the fighter's design.

Grumman, the longtime builder of Navy aircraft, may also have had a hand in developing the A-17. The company has swing-wing experience gained from building its F-14 Tomcat Navy fighter. Northrop Grumman Corp., the company that is the result of a recent corporate merger, has new permanent offices at Cannon AFB, although the F-111s based there were built by General Dynamics. The official explanation for Northrop Grumman's presence is avionics upgrade work on the EF-111 Ravens.

The A-17's propulsion is likely furnished by a pair of high-performance General Electric YF-120 turbofan-turbojet engines developed for the advanced tactical fighter. These variable-cycle engines are efficient over a broad range of speeds and pushed the YF-23 past Mach 2 during flight testing. In a flight mode known as "supercruise," they also accelerated the YF-23 to Mach 1.6 without using fuel-gobbling afterburners. Therefore, the A-17 should be able to sprint to or from a target area at supersonic speed, if needed.

Here's a legend-shattering notion: Was the triangular craft seen refueling over Britain's North Sea in 1989 ["Secret Mach 6 Spy Plane," Mar. '93] actually an A-17—and not the rumored Aurora hypersonic spyplane? PS

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Baby zoomers

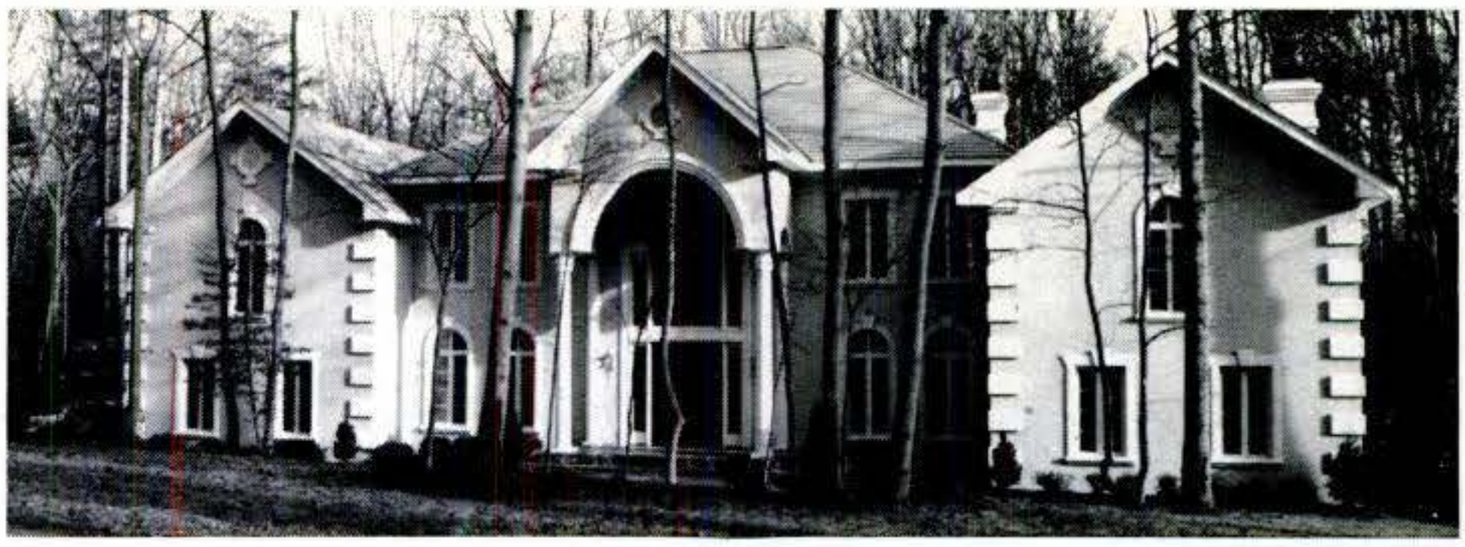
[Continued from page 67]

Stylus one of the hottest sellers in the compact category and won that camera a 1991 POPULAR SCIENCE Best of What's New Award. The clamshell design contributes to its IEC Grade 4 weatherproof status, as do its specially developed waterproof seals; the camera is safe from water splashes from any direction. The lens barrel is even coated with a unique water-repellent finish, so that when the lens retracts into the body, water droplets are whooshed away.

The Infinity Stylus wields a 35-70mm zoom lens and a 450-zone autofocus system. Exposure setting is automatic, with a useful option: When the camera is set in Spot mode, exposure will be metered from a subject in the AF mark seen in the viewfinder. If necessary, that exposure can be locked in while the scene is recomposed. Example: You want to shoot a spotlighted singer on a dark stage. An optional wireless remote control can trigger the shutter release as far as 16 feet away. The $325 camera is also superlight. At a trifling six ounces, it's the lightest in this group.

You want really, really small? The smallest camera among these tiny tots—and among all 35mm 2X zoom cameras, as far as I know—is the Nikon Lite-Touch Zoom: This baby measures just 4.6 by 2.5 by 1.4 inches. Its power zoom lens, controlled by pressing "W" (for wide) and "T" (for telephoto) buttons, ranges from 35mm to 70mm. It can focus as close as two feet, even at the higher focal length. One unusual feature: The lens is covered by a protective ultraviolet filter. When power is turned off, the lens retracts into the camera body. List price is $240.

Say "Leica" and you say top lens quality. The Leica Mini Zoom is equipped with a super-sharp seven-element 35-70mm Vario-Elmar zoom lens. Pressing a mode button repetitively provides a series of options, including the ability to override a number of automatic features and to take long time-exposures. Holding the shutter button down trips the shutter at 1.5-second intervals until the button is released. Panorama format is available only with the use of a special adaptor. If the $415 camera is not used for about five minutes after it is switched on, the data panel display and the flash unit are automatically turned off, a useful battery-saving feature. A touch of the shutter button turns everything back on. PS



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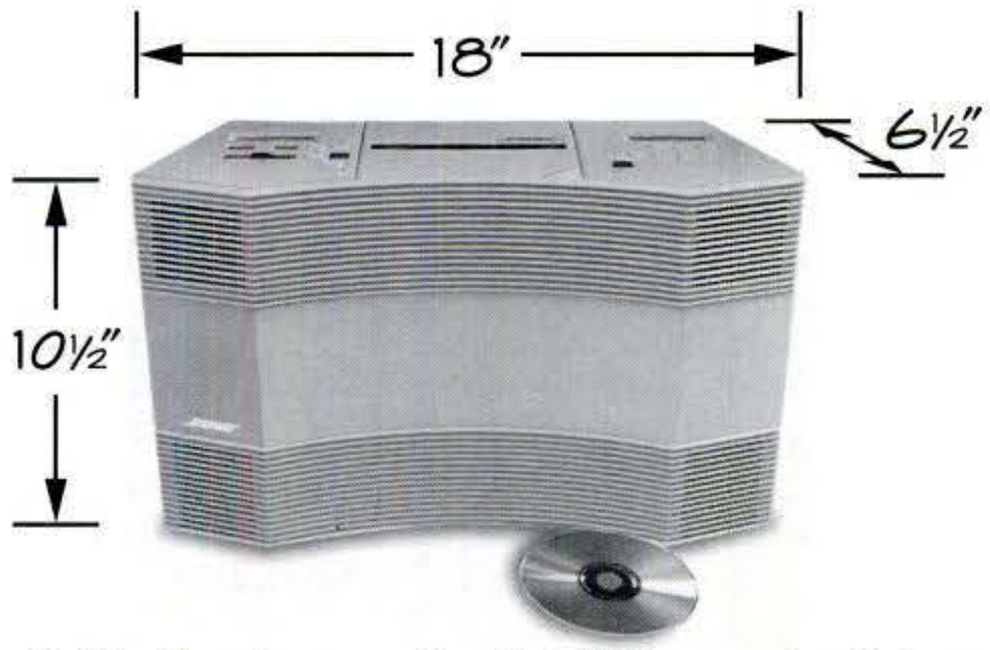

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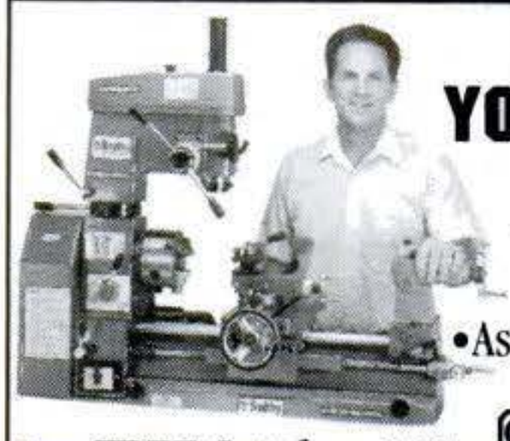

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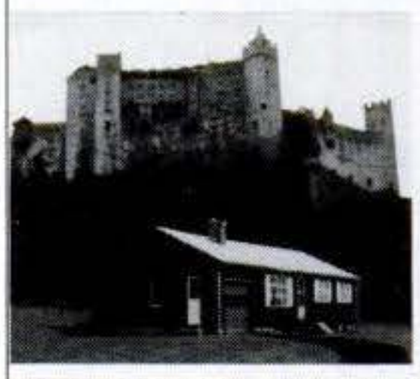

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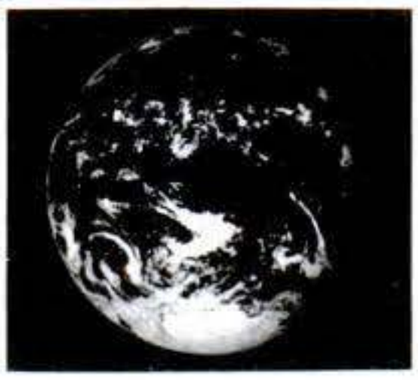

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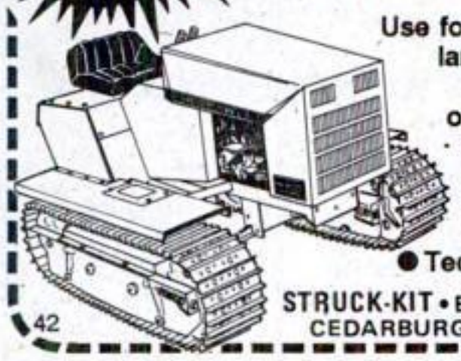

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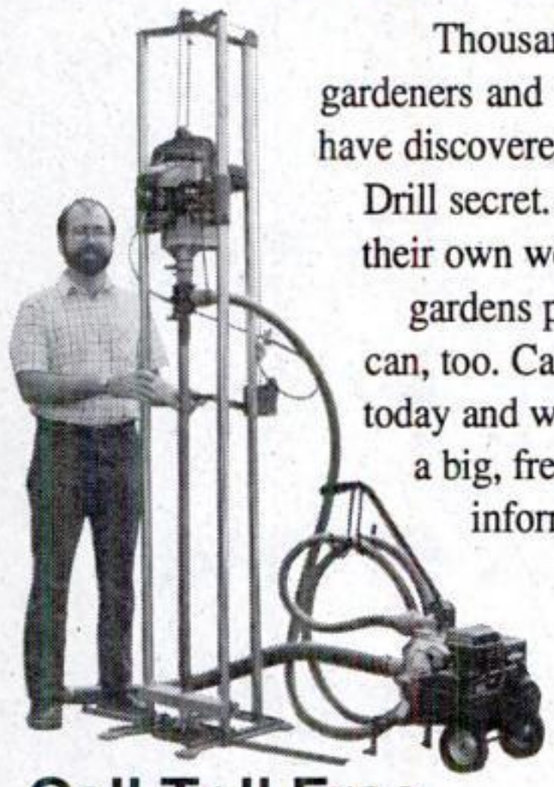

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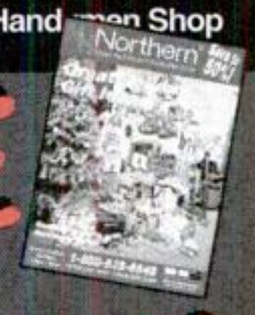

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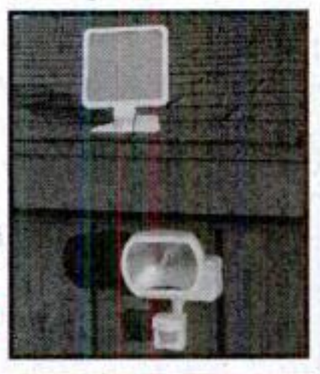

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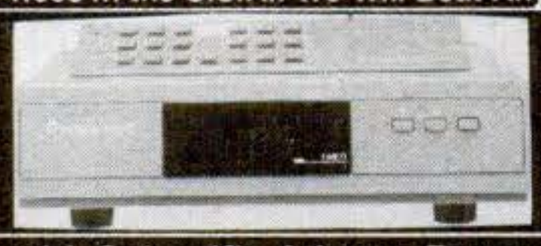

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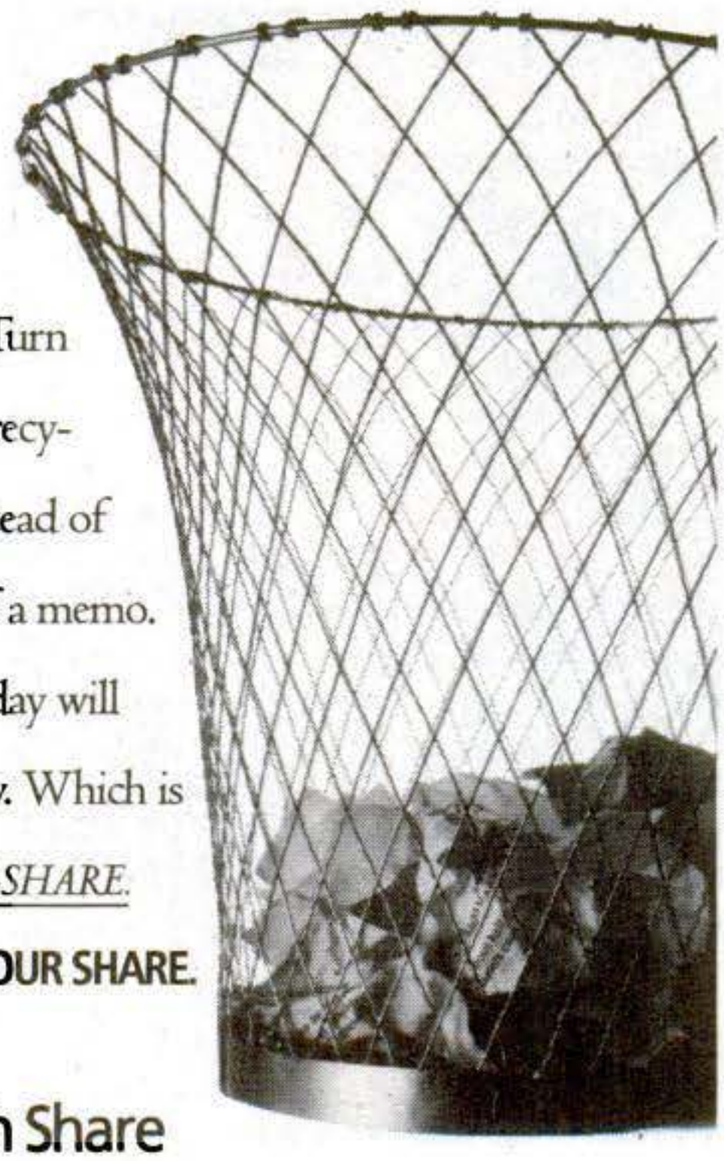

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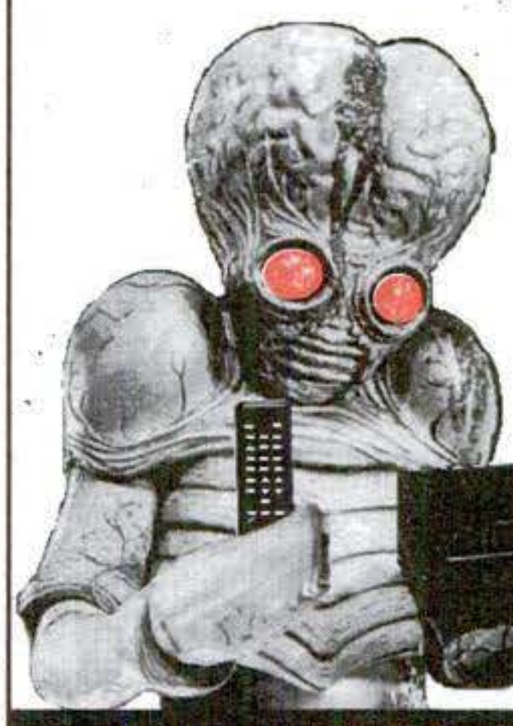

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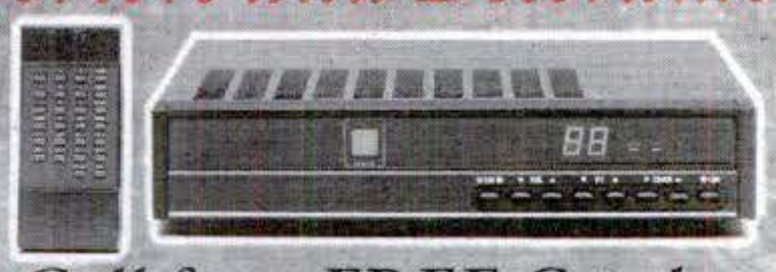

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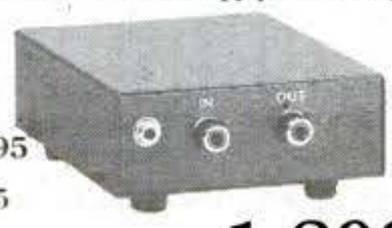

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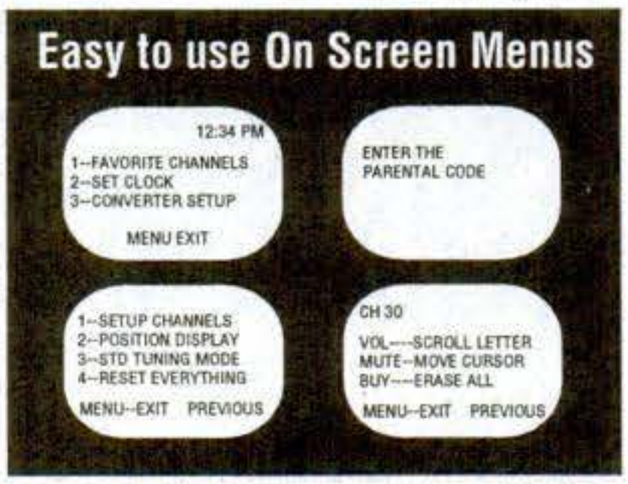

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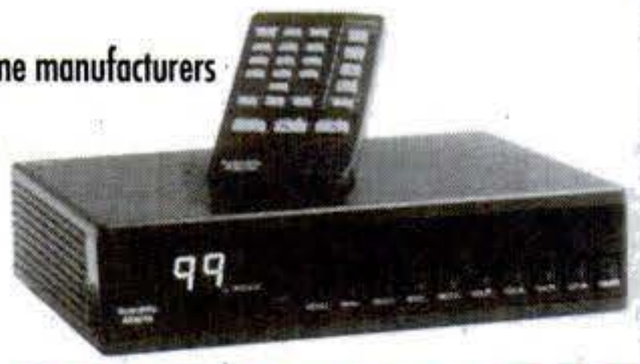

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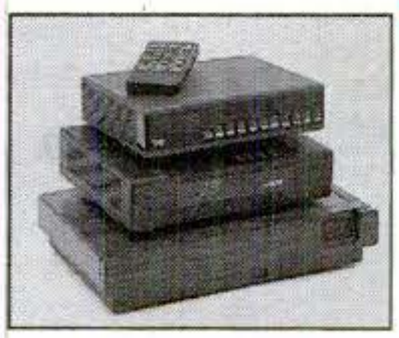

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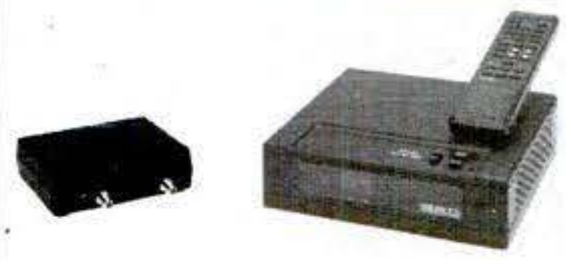

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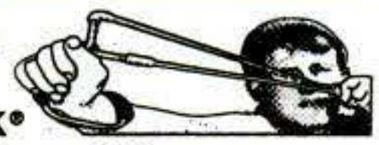

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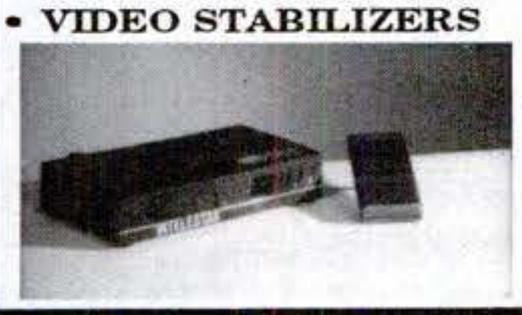

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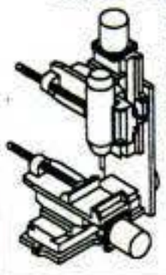

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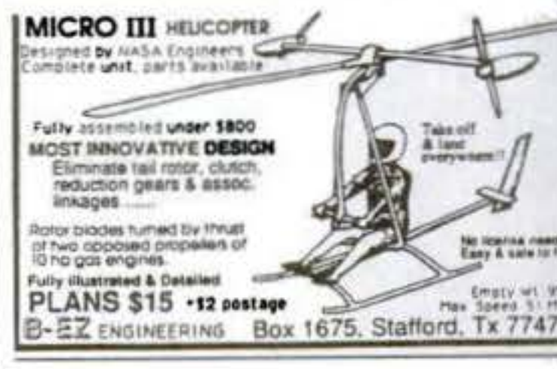

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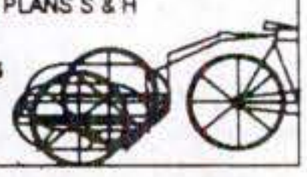

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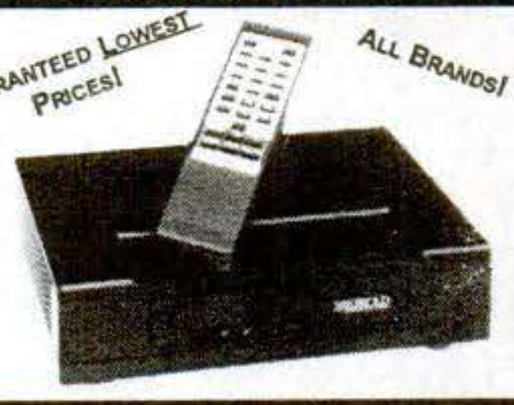

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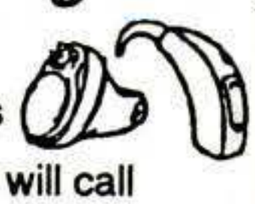

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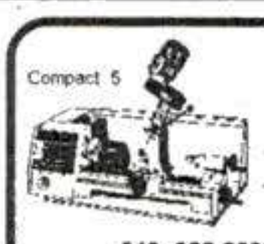
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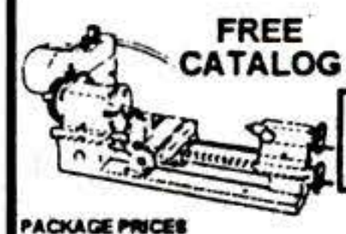
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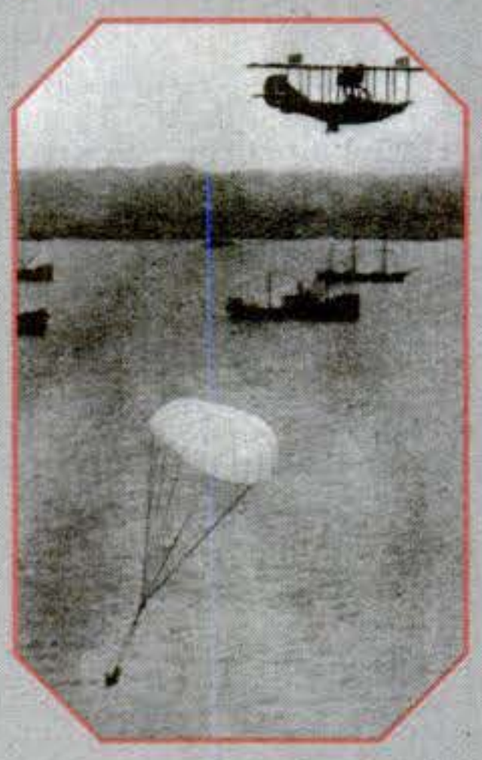
LOOKING BACK

EDITED BY WENDI E. BLACK

75 YEARS AGO

RECORD-SETTING PARACHUTE DROP



Dozens of inventors have applied themselves to the problem of providing an airplane parachute. When Major T. Orde Lees of the Royal Air Force came to this country to demonstrate an English parachute called the 'Guardian Angel,' POPULAR SCIENCE invited him to give a special demonstration. The experiment took place successfully off the Statue of Liberty in New York harbor. A drop from a height of less than 250 feet was made. This is the lowest on record from any aircraft."
—*January 1920*

50 YEARS AGO

MIGHTY BATTLE WAGON

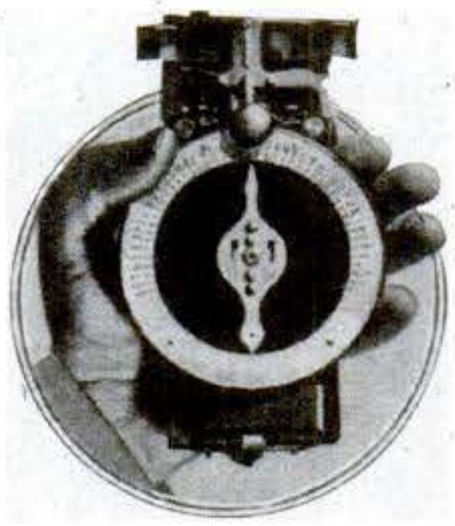
The 45,000-ton U.S.S. *Iowa* is the mightiest battleship ever built. According to the U.S. Navy, the *Iowa* makes 30-plus knots, the highest speed ever built into an American ship. Just what that 'plus' amounts to the enemy will not learn here."—*January 1945*

After an explosion in one of her gun turrets in 1989 ["What Really Happened on the Iowa," *Dec. '90], the U.S.S.* Iowa *was decommissioned.*

100 YEARS AGO

END TO SMALLPOX

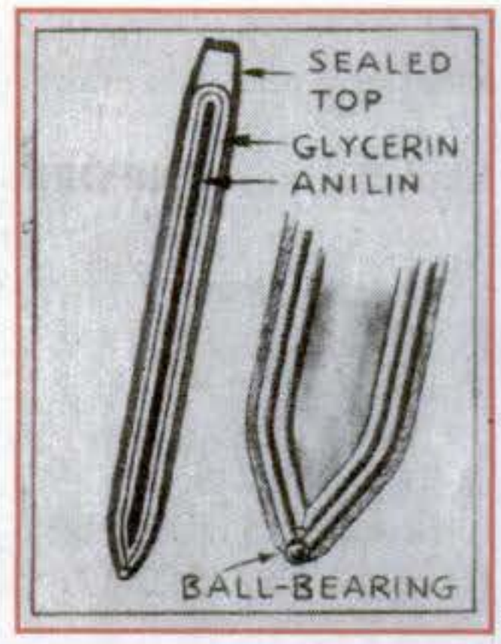
The whole subject of vaccination, revaccination, and the establishment of vaccine stations has been so frequently and thoroughly discussed that it is strange that any intelligent person should allow himself or his family to remain for a day unvaccinated." Beginning in the early 1870s, newly formed state boards of health began to mandate compulsory vaccination of school children. The results were dramatic: In Massachusetts there were 2,375 deaths from smallpox in the decade ending 1872; in the decade ending 1892 there were 51.—*January 1895*



75 YEARS AGO

PORTABLE TYPEWRITER

A typewriter small enough to be carried in your coat pocket and light enough to be held in your hand while you are writing your letter with it has been invented in France. It consists of two parts: the typewriting mechanism, which is enclosed in a small metal box; and the carriage, which holds the paper."—*January 1920*



50 YEARS AGO

BALLPOINT PEN

A two-year ink supply can be carried in a fountain pen invented by a newspaperman from Hungary. The writing point is an unbreakable ball bearing to which a gelatinous quick-drying ink is fed from a copper tube. The inventor claims that the pen will not leak at high altitudes and that one filling lasts from one to two years."—*January 1945*

25 YEARS AGO

COMPUTER-AIDED DESIGN

Designing from a model without actually making one is now a real possibility. Engineers at Western Electric are developing ways to convert a computer's natural information medium —binary bits—to pictures. A special translator transmutes numeric data into pictures on a display screen, which provides the illusion of a three-dimensional object."—*January 1970*

25 YEARS AGO

ELECTRIC BUS

The newest experimental vehicle from Mercedes-Benz is an electric city bus with a top speed a little over 40 mph. The batteries are lead-acid, weighing 3½ tons, and recharged by a small diesel-engine generator set. Though the bus is experimental, Mercedes feels that it is a first step toward the city bus of the future."
—*January 1970*

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The soldier on the right has it.

So does the soldier on the left. In fact, all the soldiers in this picture have the opportunity to earn $20,000, $25,000, or up to $30,000 for college, for a two, three or four year enlistment respectively.

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You can too. All you have to do is qualify. The Montgomery GI Bill plus the Army College Fund are great ways the Army helps you save for college. Along the way, you'll also learn things like confidence, teamwork, and self-discipline. The things that will make you better prepared for college. And for life.

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